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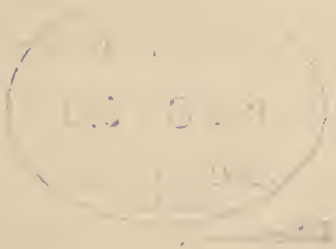

The Principles
of
Vital Statistics

By
I. S. Falk, Ph. D.
Department of Public Health,
Yale University

Illustrated

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TO

LOUIS I. DUBLIN

MY TEACHER IN VITAL STATISTICS

THIS BOOK IS RESPECTFULLY DEDICATED

FOREWORD

It is almost a truism that the progress of science is marked by the extent to which exact quantitative data replace qualitative impressions; and in the broad field of public health, as distinct from its numerous contributory sciences, methods and results can be gaged, and can be gaged only, by the intelligent use of vital statistics. Since the days when Simon was first appointed Medical Officer of Health for London and spent every Monday evening poring over the Bills of Mortality so as to formulate his plans for the ensuing week, the most successful health worker is he who orients himself by the constant and intelligent analysis of morbidity and mortality returns.

In the teaching of vital statistics to advanced students the valuable text-books of Newsholme and of Whipple have proved of the greatest assistance. With the growth of the public health movement, however, an increasing number of persons have become engaged in the production and the consumption of vital statistics, many of them necessarily without either the time or the preliminary training to pursue an exhaustive study of the subject. In particular, the courses for public health nurses which have grown up all over the country have felt the need for an elementary text which

should deal with the broad principles underlying this subject in a manner comprehensible to the reader who lacks an extensive background in mathematics.

The present book owes its inception to a course of lectures and exercises in vital statistics given in this department for several years to the students in the public health nursing course offered by the New Haven Visiting Nurse Association in co-operation with Yale University. In this course Dr. Falk has been unusually successful in arousing interest and in securing a clear comprehension of the important principles which the nurse and other public health workers must comprehend if they are to aid in the collection and interpretation of statistical data. Much of the material has appeared in the columns of the Public Health Nurse, and the author has been urged to expand it and to publish it in more permanent form in the hope that it may be of value to a wider circle of students both within and without the nursing profession. It is no easy task to present the elements of vital statistics simply and clearly and in readable fashion, but this task, as it seems to me, Dr. Falk has accomplished.

The laboratory worker goes straight to nature for the data which he is to analyze. The vital statistician must depend on material that has been molded by human hands and influenced by the intelligence and the judgment with which the data have been registered and combined. It is our hope that such a book as this

will help to make such data, as they are collected and analyzed in the United States, more accurate and more fruitful. If such is the case a real service will have been rendered to the cause of public health.

C.-E. A. Winslow.

Department of Public Health,
Yale School of Medicine.

PREFACE

THERE are in the field books upon the *theory* and *methods* of statistics which are readily available to the more advanced student. It is only because this volume avoids, so far as possible, both theory and methods and is indeed almost wholly devoted to the *results* of Vital Statistics, that with its presentation no apology is necessary. The principles presented are applicable to the Vital Statistics of any country, although the data used in the demonstrations are almost entirely concerned with the demography of the United States. Methodology has been relegated to a position of minor importance and a modicum has been included in these pages only when it is essential to an understanding of the material or where it will materially assist the student to obtain for himself statistical material of the type treated here. The necessity of limiting the size of the book is the only excuse for the omission of certain important subjects from the text.

The reader will notice with surprise—perhaps with chagrin—that the term "heredity" scarcely ever appears and that a discussion of the relative importance of *hereditary* in contradistinction to *environmental* influences upon man is notable by its absence. This omission is purposive, partly because the subject has been treated

in an admirable and splendidly readable manner by Professor Raymond Pearl in his recent publication "The Biology of Death"—of which the first seven chapters are warmly recommended, and partly because the author is not convinced that sufficient evidence is available for the accurate evaluation of these influences. He has therefore sedulously avoided—so far as it was feasible—entrance into this controversial field.

The purpose of the book is to introduce the student to the subject of Vital Statistics, to describe the more important procedures and sources of information which are commonly utilized in statistical inquiries, to indicate certain outstanding evidences and conclusions which statisticians have derived and which are of interest to students and workers in public health, and to discuss briefly certain cautions which the untrained statistician must observe in the treatment of vital statistics. For a discussion of the art of record-keeping the author recommends "Records of Public Health Nursing", by Dr. L. I. Dublin, a series of five lectures delivered before the Department of Nursing and Health, Teachers College, Columbia University, and reprinted from *The Public Health Nurse*, 1921, by the Metropolitan Life Insurance Company. For more detailed discussions of statistical material the original literature cited in footnotes and in the selected bibliography may be consulted.

It is a pleasant privilege to acknowledge the author's

indebtedness to the many persons who have aided and encouraged the preparation of this volume. Professor Winslow and Dr. Dublin will recognize many thoughts that warrant them. Thanks are due Miss M. J. Smith, the Editor of *The Public Health Nurse*, for permission to incorporate the material which was first presented in a series of Essays on Vital Statistics published in that magazine in 1922. In addition, the author wishes to express his thanks to Miss Stevens and Miss Carr, of the National Organization for Public Health Nursing, to Miss Edna L. Foley of Chicago, and particularly to Miss Mary S. Gardner, of the Providence District Nursing Association, for advice and material assistance so freely given on many occasions. It is almost gratuitous to add that the author assumes the sole responsibility for the views expressed in the text.

I. S. F.

YALE UNIVERSITY,
NEW HAVEN, CONN.,
September, 1923.

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The Principles of Vital Statistics

CHAPTER I

VITAL STATISTICS—WHAT THEY ARE

THE human brain is accustomed, in a certain measure, to think in terms of numbers. It is a fact that provided numbers or objects do not exceed ten in number they are easily grasped or comprehended even by the individual who has not had a mathematical education. When greater numbers or groups must be dealt with —added or subtracted, divided or multiplied, or must be described or analyzed—the difficulties increase considerably, and commonly become too great even for the person with the greatest mathematical aptitudes. Man must have recourse to methods of description other than those which are used in the conduct of everyday life. He makes use of *statistics* when possible or practicable; he systematically compiles facts or instances, usually in numerical terms, and then studies these compilations by *statistical*, generally mathematical, procedures. If the statistics have been collected accurately, with the observance of certain precautions which will be discussed later, and if the *statis-*

tician is sufficiently capable and ingenious he will deduce conclusions from the data which were not evident without statistical analysis or which could not have been proved without quantitative, statistical description of the facts.

Use of Statistics.—Broadly speaking, statistical description is utilized in three types of problems:

1. To describe or to analyze events which have occurred in time now past.

2. To describe objects or facts or to study events which are occurring.

3. To find out what has happened in the past in order to predict the future. Examples of all of these types of problems will be presented as the subject is developed.

Are Statistics Dry?—In schools in which courses of instruction in *statistics* are given the teachers find that they have two tasks which they must accomplish before they can begin to teach. The first is to convince the pupils that statistics are not "dry"; and the second is that it is not true you can prove anything with statistics. Both of these are beliefs which are almost universally held by laymen. In statistical studies, as in any others, it soon becomes evident to the student that the more he knows about the subject, the more interest and absorption it holds for him; and, conversely, the less he knows, the less he is interested. Pages of figures by themselves do not constitute sta-

tistics. They must be accompanied by detailed information of what they apply to, whence they were obtained, and by whom, what corrections and additions have been made to them, what is lacking in them, what they mean, etc. Figures plus such information begin to constitute *statistics* and to become interesting. Bare figures have no more interest to the statistician than a list of names of muscles to the anatomist. It is in their connection with other facts, in their significance, in the validity of the interpretations to be placed upon them that they begin to arouse interest. The science of statistical inquiry approached from this point of view usually becomes very interesting even to the most elementary student.

Accuracy of Statistics.—Statistics have been known to indicate or to appear to prove untruths, and hence the unwarranted belief that "figures lie" is commonly met with. Occasionally it appears that "liars can figure"; more often the reason why statistical proofs are in disrepute is that too many people do not know how to collect or to study statistics accurately. Not only the untrained investigator, but even the professional statistician may—and frequnetly does—make errors in the *collection* or *analysis* of statistical data. And probably no humans—still less statisticians—are free from the liability of error in interpreting statistical or any other kind of evidence. The statistical method is a keen-edged tool, and like any other keen-edged tool

it must be handled with care and discretion. Statistics accurately compiled are always truthful. Sound analysis of them demands careful, scientific thinking. If this is lacking and inaccurate deductions are made from them, the error lies with the interpreter and not with the statistics.

Statistical Methods.—It would be too lengthy a task to undertake a description of representative *methods* which are used in statistical studies. These will become familiar as specific problems are discussed in later chapters of this book. The statistical method of analysis is nothing more or less than a tool by means of which a group or an *array* of figures may be arranged and analyzed so that for the large group or collection a single figure, an *average* perhaps, may be substituted which will typify the entire group—a single figure or a small number of figures which will tell at a glance what the eye or the mind fails to perceive by inspection of the larger group. In some cases this result is obtained most easily and to greatest advantage by arrangement of the data in the form of a statistical *table*. In other cases the same purpose is better served by the use of a *graph* or *plot*. The actual forms of table and graphs which are most commonly and most advisedly used will be illustrated later.

Vital Statistics Applied.—Statistics are used in a large number of fields of human interest, in a multitude of business as well as scientific problems. Statistics

which apply to problems of human life are part of the science of *demography* (a name which comes from the two Greek words *demos*, the people, and *graphy*, the description). Those which are concerned with certain fundamental events of human lives, such as birth, marriage, sickness, and death, belong to the field of *vital statistics*, a special branch of demography.

The student who has been trained in biology, particularly in that branch of biology which is termed *genetics*, is accustomed to study such problems as the length of oak leaves, the occurrence of blue or black or brown eyes in a particular species, or the color of horses by statistical methods. In the practical fields of public health work a health officer, a physician, a nurse, or a bacteriologist is not concerned with the problems of the geneticist, but he or she utilizes the same methods of analysis. The health officer of a city collects from the recorded death certificates a figure which represents, for example, the total number of deaths which occurred in his city during the period of a year. He compares this figure with one similarly obtained from the death certificates of the previous year or with the average from those for the ten preceding years, and finds that it is 5 per cent. lower. He is interested in finding out why the number of deaths has decreased. Is it because the city has decreased in population or is it because of the antituberculosis and the infant welfare campaigns which have been recently launched? Has there been

a decrease in number of deaths among infants, young adults, old people, or is it evenly distributed throughout the span of life? To find the answers to these questions he must make further statistical analysis of the data on his death certificates. The Director of the Visiting Nurse Association in the city of A—— finds that there are an excessively large number of deaths of infants and children under two years of age. What measures shall be resorted to? Are the deaths due to causes which are prenatal in origin; are they puerperal or postnatal; are they due to malformations, malnutrition, or to communicable diseases? Obviously, the answer to the second question will determine that of the first. And accordingly there will be launched a campaign of prenatal and natal education and care of the mothers; a campaign aiming to educate and control the midwives or to furnish trained nurses at childbirth; or to locate, isolate, and eradicate carriers of communicable diseases and to educate mothers in the care of the susceptible infants. Or perhaps a program calling for education in diets of infants, the provision of clean, wholesome milk, and clean, cool infant welfare stations in the needy districts of the city will provide the necessary measures.

Vital statistics is the logic of the statistical method applied to the fundamental events of human lives. To the worker in any field of preventive medicine it provides the gages by means of which he measures the need

for any particular kind of work as well as the success or failure of his efforts. The bacteriologist, the physician, the engineer, the chemist, the nurse, the educator, and their allies in this work are, by themselves and with their own type of knowledge, at a loss in public health fields because they do not have accurate methods of finding out what ails a community and what it needs most. They must be equipped with records and statistics of the population's composition with respect to age, sex, and race proportions, of births, deaths, sicknesses and recoveries, and many more fundamental facts. They must have the *vital statistics* with which to measure and weigh their problems and to evaluate the results of their labors.

CHAPTER II

THE CENSUS AND THE COMPOSITION OF THE POPULATION

THERE are very few, if any, better methods of learning about the sanitary conditions of a given population than by turning to the best available vital statistics. The sanitary or biologic condition or state of affairs of a given community is expressed statistically by the ratios of deaths and of diseases to the population. There are, therefore, two fundamental statistical elements to consider: First, the statistics of *population;* and second, the statistics of *morbidity* (sickness) and *mortality* (deaths). The sources and nature of statistics of population will be taken up in this chapter, and of morbidity and mortality in subsequent chapters.

Statistics of Population. Sources.—The first consideration in population statistics is the accurate determination of the total number of people in the community. Following this other characteristics of the population must be determined. The number of people may be determined by:

(*a*) Enumeration taken by a census.

(*b*) Estimates.

A *census* is an enumeration of a population made by persons called *enumerators*, who go from house to house in a definite locality and obtain information about the number of persons residing in each place of residence, their sex, age, marital or blood relationship, etc.

Census data are available in all civilized countries of the world. They vary, however, in the frequency with which they are repeated or retaken; in their extent, completeness, and accuracy. With reference to census data—as with any statistical data—it is essential that the limitations in the accuracy of the data be very carefully scrutinized before interpretation of *statistical* facts is attempted.

The United States Census.—In the United States a census enumeration of the whole population is made once in ten years. The taking of the census is required by the Constitution of the United States for the primary purpose of supplying the population basis for the apportionment of Representatives in Congress. The first census of the United States was taken in 1790, and a census has been taken on each tenth year since. The census of 1920 was the Fourteenth (Decennial) Census. The first census report included information obtained from the tabulation of answers to six simple questions. The later census questions are more numerous and the reports are proportionately larger. The tabulated results of the Thirteenth Census were contained in eleven large volumes besides a separate "Abstract"

volume.[1] The census data usually appears in preliminary form shortly after the taking of the census, and in final form a couple of years later. At the present moment only Volumes I, III, VI, VII, and part of Volume II of the Fourteenth Census (1920) are available. The material tabulated in this chapter has, therefore, been taken from the data for 1910 and 1920. So complicated has become the task of organizing, tabulating, and editing (rearranging and partially interpreting) the census data that special machinery and hundreds of employees are required for the task.

Originally (1790, 1800, 1810, and 1820) the census date was the first Monday in August. In 1830 the date was changed to June 1st because it was assumed that the population in the middle of the year would be more nearly representative of the population of the whole year. Presumably, the midyear data would approximate the *average condition* of the fluctuations which occur during the year. Beginning with the Census of 1910, the date was changed from June 1st to April 15th, because a considerable number of persons are away from their homes in June. These persons are therefore "missed" when the census enumerators make the rounds. The law provided that census enumerators shall begin work on April 15th, and shall complete the

[1] Volumes I, II, III, and IV contained the statistics of Population; V, VI, and VII, of Agriculture; VIII, IX, and X, of Manufactures; and XI, of Mining. Volume IV (Occupation Statistics) contains particularly valuable information for social and health workers.

enumeration within two weeks in cities of 5000 inhabitants or more, and within thirty days in smaller places and in rural communities where larger areas must be covered. In 1920 the census-taking date was changed by Act of Congress to January 1st, chiefly because of the increased value of the statistics on agriculture when they apply to the conditions on farms at the beginning of the calendar year.

On the enumerator's sheets for the Fourteenth Census (1920) there were twenty-nine items of information to be obtained about each person. The principal ones were:

1–4. Place of abode.
5. Name.
6. Relation to head of family.
7, 8. Ownership of home.
9–12. Sex, color or race, age, marital condition.
13–15. Citizenship.
16–18. Education.
19–24. Nativity and parentage.
25. Ability to speak English.
26–28. Occupation.
29. (Farm schedule information.)

The volumes of the census reports contain tabulated information on all of these subjects.

State Censuses.—In some states enumerations of the whole population are made at regular intervals, generally ten years. The dates are so chosen that these will fall midway between the dates of the national censuses.

In New York State, for example, a census was taken in 1905, and another in 1915. The United States Census dates were 1900, 1910, and 1920. This makes statistical data for the state available each five years.

School, Police, etc., Censuses.—These are generally enumerations of the total numbers without detailed classifications, and consequently they are of great value only in communities in which rapid population changes are occurring.

Estimates of Population.—For *intercensus* years (the nine years between two consecutive censuses) estimates of population may be made by computation on the basis of previous census data. The *arithmetical* method of estimation assumes that the changes in population which have occurred have been uniformly the same, year after year, and that the same change in population which has occurred annually in the past will continue in the future. For example, if in a city, A, the population in 1900 was 100,000 and in 1910, 110,000, the total increase for ten years was 10,000 and the average annual increase was 1000. Hence the population for 1911 is estimated as 111,000; and for 1915 as 115,000. Obviously, this method is open to criticisms which will occur to the student. Immigration and emigration, economic fluctuations, etc, often produce changes which invalidate such estimates.

The *arithmetical* method of estimating populations in intercensus years is the same as that by means of which

increase in money at *simple* interest is calculated. Another, more complicated, method is similar to that of *compound* interest accumulation, and is known as the *geometrical* method.

In the United States the arithmetical method is used commonly because it has been found to correspond with the facts more closely than the geometrical, and because it is very much simpler and, hence, can be used uniformly over the country by persons who have difficulty with the mathematics involved in the calculation by the geometrical method. The *graphical* method of estimating intercensus populations is very commonly used because of its comparative simplicity and because of the reasonable accuracy of the results which can be obtained with it. To use this method one has only to prepare a graph of the populations at successive census years as in Fig. 1 (solid line), and then to read on the population scale the figure which corresponds to the height of the curve directly over any particular intercensus year. Other methods of estimating populations in intercensus years depend upon the use of school and police censuses, upon the number of voters at elections, inhabited dwellings, local directory returns, etc.

It is important to keep clearly in mind that although the census of 1790 was scarcely more than a count of the population, the more recent censuses are very much more. The modern census is a characterization, a description, as well as an enumeration, of the population. It gives

us accurate facts about the *composition* and *nature* of the population as well as its number. Even as the population of the United States has been growing larger and larger numerically, and increasing continually in complexity and diversification, so the census has been growing.[1]

Growth of the Population.—Table 1 and Fig. 1 present the outstanding statistics which show the growth of the population of the United States (exclusive of the outlying possessions).

TABLE 1

POPULATION OF THE UNITED STATES: 1790–1920

Census year.	Population.
1790	3,929,214
1800	5,308,483
1810	7,239,881
1820	9,638,453
1830	12,866,020
1840	17,069,453
1850	23,191,876
1860	31,443,321
1870	38,558,371
1880	50,155,783
1890	62,947,714
1900	75,994,575
1910	91,972,266
1920	105,710,620

[1] The history of the American census, some of its outstanding findings, descriptions of the organization and of the schedules, blanks, and tabulating machines employed by the Census Bureau are described in two very interesting, short pamphlets obtainable from the Director of the Census, U. S. Department of Commerce, entitled: "American Census Taking" (reprinted from the *Century Magazine* for April, 1903) and "The Story of the Census, 1790–1916."

It will be interesting to note that the population of the United States has been growing steadily and that in the years 1900–1910 there was registered an increase of about 16,000,000 persons (21 per cent.) and in the years 1910–1920 nearly 14,000,000 (15 per cent.).

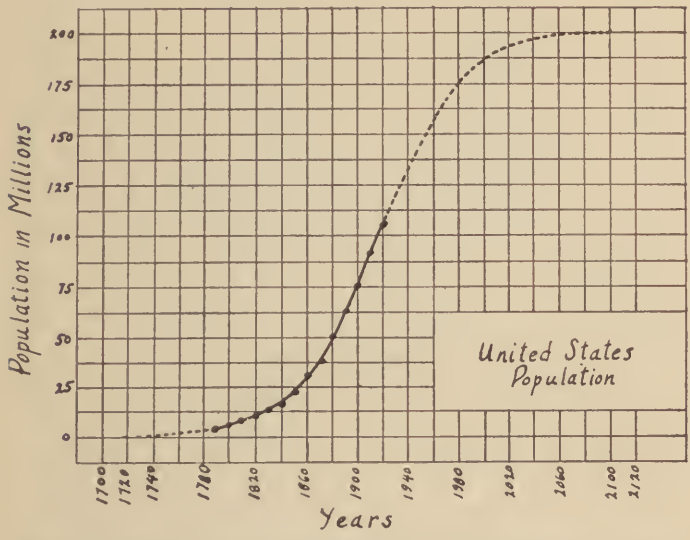


Fig. 1.—Growth of the population of the United States, 1790–1920 (after Professor Raymond Pearl).

Professor Raymond Pearl, of Johns Hopkins University, published recently some interesting calculations of the growth of populations. Figure 1 has been prepared from the census data for the United States (1790–1920) by his method. The *solid* line shows the growth of population in the census-taking period of one hundred and thirty years; the dotted line shows the

tendency for population growth, based upon certain empirical calculations. The fit of the *solid* upon the *dotted* lines is exceedingly good. The indication is that the population of the United States is growing in such a manner that it will be at the maximum (about 179,000,000 persons, roughly twice the present population) in about the year 2100.

Increases in the Population.—The sources of increase in the population are of two kinds: 1, Natural. 2, Excess of immigration over emigration. The *natural* increase of population is the excess of births over deaths and usually amounts to about 1 per cent. of the population per year. There are commonly about 25 births and about 15 deaths each year in each group of 1000 persons. The difference of 10 per 1000 (equals 1 per cent.) represents the excess of births over deaths. The excess of immigration over emigration has at times amounted to 750,000 per year. In the last decade (1910–1920), owing to the unusual conditions created by the World War, immigration fell off considerably. It is now held at a low level by restrictive legislation. In 1920 the population of the United States (including the outlying possessions) was nearly 118,000,000 and constituted approximately 7 per cent. of the world's population.

The Relation of Population to Area.—The *density of population* is the population per square mile. The total land area of the United States (1920) is a little under

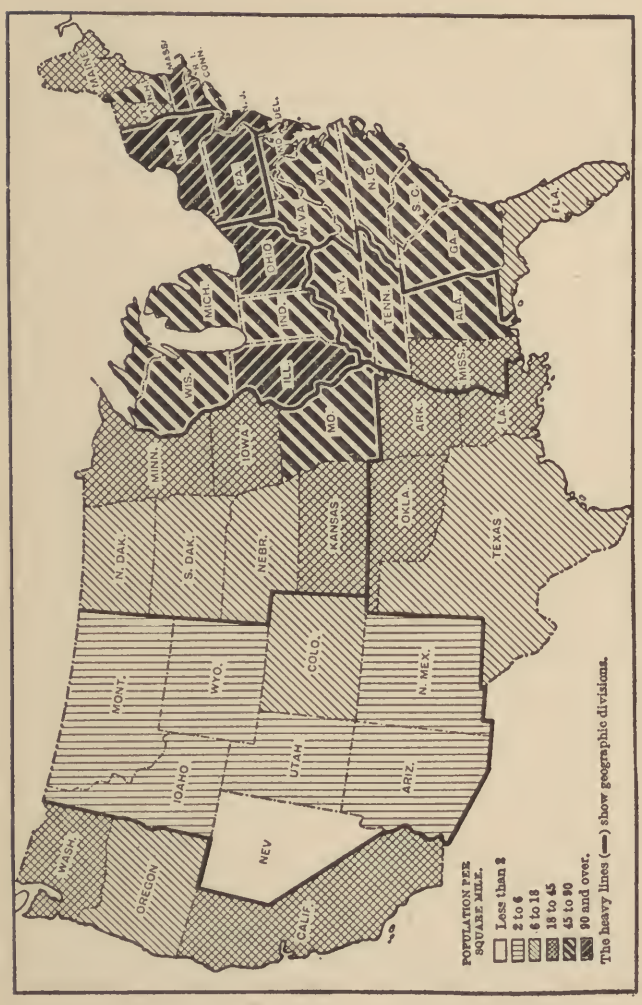


Fig. 2.—The density of population in the United States in 1920 (from U. S. Census, 1920, Vol. I).

3,000,000 square miles. When this is divided into the population (1920) it gives an average population density

of 35.5 (persons per square mile). In considering problems of community or municipal overcrowding it is scarcely accurate to use this figure, which is merely an average, as descriptive of any special situation. It represents the average condition between the extremes of 7293 persons per square mile for the District of Columbia and 0.7 persons per square mile for Nevada, the former being 70,000 times more populous on the average than the latter. Even in restricted localities there are extreme variations. In 1910 the average density of population of the Middle Atlantic States was 190.3. In certain mountain regions it was as low as 3.1.

Urban and Rural Populations.—Any geographic unit with a population greater than 2500 is considered *urban;* any with fewer is considered *rural.* The distribution of the population between urban and rural areas, as reported at each of the last five censuses, is given in Table 2.

TABLE 2

URBAN AND RURAL POPULATION OF THE UNITED STATES: 1880–1920

	Percentage of population				
	1880.	1890.	1900.	1910.	1920.
Urban.....	28.6	35.4	40.0	45.8	51.4
Rural.....	71.4	64.6	60.0	54.2	48.6

When examining the data in Table 2 it is to be remembered that *both* the urban and rural groups are increasing in numbers. What is happening is that the *relative* distribution of people between the urban and rural areas is changing, the urban districts growing more

rapidly than the rural. The natural increase as well as the increase due to excess of immigration over emigration affect both the urban and rural populations. In 1920, for the first time, more than one-half of the population of the country resided in the cities (urban area).

Color, Race, Nativity, and Parentage as Factors in the Population.—It will be brought out later that when an attempt is made to compare the relative healthfulness of two or more communities, extreme caution must be observed before the comparison can be considered valid. Before the mortality or morbidity records of a community are compared with those of another in order to indicate the relative sanitary levels of the two localities the similarity of the population in the two places must first be demonstrated. Aside from any *age* or *sex* factors it is well to remember from the outset that different racial groups have different susceptibilities to diseases at all and at different ages in life. Every public health worker must take into account in his work the make-up of his population. It is radically unfair sometimes to compare two places as to death or birth data unless the two populations are of the same racial compositions, and have the same proportions of males and females and of old and young persons.

In the United States the racial composition is subject to continuous changes. What was true about it seventy-five years ago may be untrue today.

In the United States Census the whole population is

divided into six racial groups: (1) White; (2) Negro; (3) Indian; (4) Chinese; (5) Japanese; (6) All others. The white population is further subdivided into the following groups:

1. Native:
   (*a*) Native parentage—both parents born in the United States.
   (*b*) Foreign parentage—both parents born in foreign countries.
   (*c*) Mixed parentage—One native and one foreign parent.
2. Foreign born:
   This group, if large enough, is further subdivided according to the country of birth.

White and Negro Populations in the United States.—The white and the negro races are predominant in the United States. That the relative proportions of the two has not been unchanging in the hundred and twenty years for which we have census data is indicated by the figures in Table 3.

TABLE 3

THE DISTRIBUTION OF RACES IN THE POPULATION OF THE UNITED STATES: 1790–1920

	Percentage of population			
Race.	1790.	1850.	1910.	1920.
White	80.7	84.3	88.9	89.7
Negro	19.3	15.7	10.7	9.9
All others	....	....	0.4	0.4

The proportion of negroes in the population has been decreasing. At first sight it might appear from these

statistics that the negroes are dying out, and that their total number in the country has been decreasing. That this is not true is indicated by the data in Table 4, which show that the negro population has been increasing steadily since 1790. Their diminishing proportion in

Fig. 3.—The proportion (per cent.) of negroes in the total population according to states in 1920 (from "United States: Composition and Characteristics of the Population," Bureau of the Census, 1920).

the whole population means that they are not increasing as rapidly as the whites.

TABLE 4

GROWTH OF THE NEGRO POPULATION IN THE UNITED STATES: 1790–1920

Year.	Population.
1790	757,208
1850	3,638,808
1910	9,827,763
1920	10,463,131

The white plus the negro population makes up nearly the total in the United States.

Changing Nativity of the Population.—In recent years a considerable amount of attention has been focussed upon the problem of the changing proportions of native and foreign-born persons in the population. Until the details of the 1920 Census became available we could not know the extent of these changes since 1910. The figures in Table 5 are taken from the United States Census reports. They describe the proportions of native and foreign white groups between 1850 and 1920:

TABLE 5

THE NATIVITY AND PARENTAGE OF THE WHITE POPULATION OF THE UNITED STATES: 1850–1920

Census year.	Percentage of total white population: Total.	Native white		Foreign-born white.
		Native parentage.	Foreign or mixed parentage.	
1850	88.5	....	....	11.5
1900	84.7	61.3	23.4	15.3
1910	83.7	60.5	23.1	16.3
1920	85.5	61.6	23.9	14.5

These figures indicate that the predominance of the native-born white population had been *decreasing* in the years 1850 to 1910, and that the proportion of foreign-born whites had been increasing correspondingly. In the decade 1910–1920—particularly in the war years—immigration of foreign stock was restricted by legislation as well as by the difficulties involved in migration under war conditions. In the decade 1900–1910, on the

average, 820,000 immigrants arrived each year; in the decade 1910–1920 the average annual immigration was 635,000. It is significant to note two facts: (1) The changes in the percentage of the white population which was of foreign birth in the years 1850–1910, although occurring over a period of sixty years, amounted only to 4.8 per cent.; (2) in the years 1910–1920, with fully three-quarters of the immigration of the preceding decade, the native-born white population increased by 1.8 per cent. and constituted (January 1, 1920) a larger portion of the white population than at any time since the years preceding the beginning of the century.

Further examination of the data in Table 5 indicates that the *native* stock of *native parentage* was essentially the same percentage of the total white in 1920 as in 1900. The foreign-born persons constituted 11.5 per cent. of the white population in 1850, 15 3 per cent. in 1900, and 14.5 per cent. in 1920.

Countries of Birth of the Foreign Born.—In 1920 there were in the United States a total of some 13,700,000 foreign-born white persons. Table 6 shows how many

TABLE 6

SOURCES OF THE FOREIGN-BORN WHITE PERSONS IN THE UNITED STATES, 1920

Source.	Number.	Percentage of total.
Total foreign born	13,712,754	100.0
Born in Europe	11,877,991	86.6
America	1,656,801	12.1
Asia	110,450	0.8
All others	67,512	0.5

of them came to this country from Europe, Asia, other parts of North, Central and South America, and from all other parts of the world.

Thus it appears that by far the greatest portion of our foreign-born population came to the United States from European countries (roughly, 87 per cent.) and

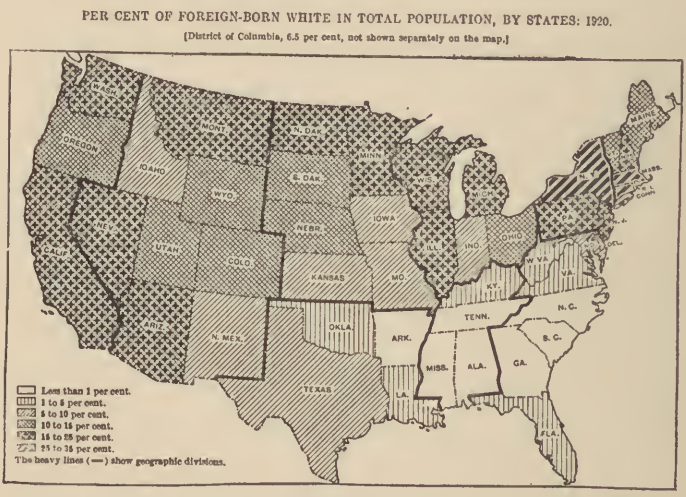


Fig. 4.—The percentage of foreign-born white persons in the total population in each of the states in 1920 (from "United States: Composition and Characteristics of the Population," Bureau of the Census, 1920).

that every geographic division of the world is represented. This fact is commonly observed in nearly all parts of the country by daily contact with persons of foreign birth. Most of them, we know, have come to our shores from one or another part of Europe. Of these foreigners of European birth (in 1910) about 57 per

cent. came from countries in *northwestern* parts of Europe (*i. e.*, Great Britain, Ireland, Germany, Scandinavian countries, Netherlands, Belgium, Luxembourg, France, and Switzerland) and about 43 per cent. from *southern* and *eastern* Europe (*i. e.*, Portugal, Spain, Italy, Russia, Austria-Hungary, and the Balkan peninsula). The proportions of our foreign born from Europe by their nativity is given in Table 7 which is shown on pages 42 and 43.

In the census years 1900 and 1910 persons of European birth constituted about the same portion of the total foreign-born population. However, in 1900 persons from northwestern Europe made up nearly 70 per cent. of the total foreign born, they constituted less than 40 per cent. in 1910, and less than 30 per cent. in 1920. In the last twenty years there have been particularly important increases of foreign-born persons from southern and eastern Europe. These changes in the *nativity* of our foreign population have meant corresponding changes in race proportions, have not been without effects upon our social and sanitary problems, and are basic in our present-day restrictive legislation for the control of immigration. The program for immigration control which is at present in force has already demonstrated its unsoundness in many respects. A grave duty falls upon those who may aid in modifying it according to sound humane principles of sociology instead of political expediency.

TABLE 7

COUNTRIES OF BIRTH OF THE FOREIGN-BORN WHITE PERSONS IN THE UNITED STATES IN 1910 AND 1920

Country of birth.	Percentage of total: 1910.	1920.
Northwestern Europe	31.8	28.3
England	6.6	5.9
Scotland	2.0	1.9
Wales	0.6	0.5
Ireland	10.1	7.6
Norway	3.0	2.7
Sweden	5.0	4.6
Denmark	1.4	1.4
Netherlands	0.9	1.0
Belgium	0.4	0.5
Luxembourg	....[1]	0.1
Switzerland	0.9	0.9
France	0.9	0.9
Alsace Lorraine	....	0.3
Central Europe	31.2	31.5
Germany	18.7	12.3
Poland[2]	....	8.3
Czechoslovakia	....	2.6
Austria	8.8	4.2
Hungary	3.7	2.9
Serbia	....[1]	....
Montenegro	....[1]	....
Jugoslavia	....	1.2
Eastern Europe	13.8	13.1
Russia	12.0	10.2
Lithuania	....	1.0
Finland	1.0	1.1
Rumania	0.5	0.7
Bulgaria	0.1	0.1
Turkey in Europe	0.2	....[1]
Southern Europe	11.5	13.9
Greece	0.8	1.3
Italy	10.1	11.7
Spain	0.2	0.4
Portugal	0.4	0.5
Total Europe	88.3	86.8

Country of birth.	Percentage of total: 1910.	1920.
Asia	1.4	0.8
America	10.9	12.1
Canada	9.0	8.1
Newfoundland	....[1]	0.1
Mexico	1.6	3.5
West Indies[3]	0.2	0.2
Central and South America	0.1	0.2
All others	0.3	0.5

[1] Less than 1/10 of 1 per cent.

[2] Poland included with Germany, Austria, and Russia in 1910.

[3] Except Porto Rico in 1910.

The Sex Factor in the Population.—Generally speaking, there are approximately as many males as females in a population. Accurate data usually show, however, that there are some differences in the proportion of the sexes. In 1916, for example, in a large part of the United States for which accurate and complete statistics of births are at hand, it was found that there were born 1057 males for each 1000 females. The ratio of the sexes at the time of birth differs somewhat in different countries, and from time to time. It is universally true, though, that there are more males than females at birth, and that the ratio is in the neighborhood of 105 males to 100 females. No satisfactory explanation of this phenomenon has ever been advanced.

The causes of mortality affect the two sexes differently at different ages of life, and hence the ratio of the sexes at each age may be considerably different from that at birth. Ordinarily in the early ages of life

more males than females die until a point is reached when the numbers of the two in the population are equal. From that point on there is generally an excess of females over males which may reach considerable proportions. At times this has not been so in the United States because of the excess of males over females among immigrants.

The ratios of *males per 100 females* which existed in the United States in 1910 and in 1920 are presented in Table 8.

TABLE 8

MALES PER 100 FEMALES ACCORDING TO NATIVITY AND PARENTAGE. UNITED STATES: 1910 AND 1920

	1910.	1920.
Total population	106.0	104.0
Total white population	106.6	104.4
Native white population	102.7	101.7
Of native parentage	104.0	103.0
Of foreign or mixed parentage	98.5	98.6
Foreign white population	129.2	121.7
Negro population	98.9	99.2

The relation of the sexes in urban and rural districts of the United States is shown by the data in Table 9.

TABLE 9

RATIO OF MALES PER 100 FEMALES FOR URBAN AND RURAL AREAS IN THE UNITED STATES, 1910 AND 1920

Nativity group.	Urban		Rural	
	1910.	1920.	1910.	1920.
Total population	101.7	100.4	109.8	108.0
Native white, total	97.3	96.9	107.1	106.7
Of native parentage	99.3	98.6	106.7	106.3
Of foreign parentage	95.1	95.0	110.9	110.4
Of mixed parentage	93.2	92.5	106.6	107.2
Foreign-born white	119.0	115.9	159.7	141.8

It appears that in 1910 and in 1920 the ratio of males to females was higher in the rural than in the urban districts. This was true for each important nativity group of the population. This observation is generally associated with the greater attraction of city life for females than for males, and with the greater demand for female industrial and domestic employees in the cities and for male laborers in the rural parts. The negroes usually also show a distinct preponderance of females in the cities, and the foreign-born whites a particularly high excess of males over females in the rural parts. The excess of negro females in the cities is usually ascribed to the fact that they are in demand for household service. The excess of foreign-born whites in rural districts is presumably due to their employment on farms.

These differences in male and female proportions are often of considerable importance in the statistical studies of societal and sanitary problems. When dealing with factors or conditions which are particularly pertinent to either the one or the other sex these male-female ratios must be kept in mind. When comparing mortalities of mothers for different communities according to the crude death-rates of the communities, for example, it is necessary to recognize that differences in the sex ratios of their populations may account for different rates of dying.

In studies of industrial accidents, of the frequency of industrial diseases or of mortality in persons of adult

ages, variations in the male-female ratio may introduce serious statistical complications.

Distribution of Persons According to Age.—The factor of age in the population is one of the most important in all considerations of statistics upon societal, economic, and health programs. The separation of the population into age groups is sometimes a very difficult procedure, and yet is one wh ch is of very great importance, sufficient to warrant a considerable amount of effort. For American census and statistical purposes it is customary for age to be tabulated according to the last birthday. This procedure allows of accurate simple results except in the case of infants. (The special problem of infant ages cannot be taken up here.) The truly great importance of age statistics will appear more convincingly later when we undertake the study of morbidity and mortality statistics and find out how enormous are the differences in the sickness and death-rates of different age groups and what errors they introduce when making comparisons of sanitary conditions in different localities by the use of morbidity or mortality data.

It is customary to divide the population into the age groups listed in Table 10. Sometimes the first five years of life are taken individually instead of collectively, and more often only the first year is taken separately.

In countries in which immigration and emigration

factors play no considerable part, the age distribution of the population does not vary considerably in dif-

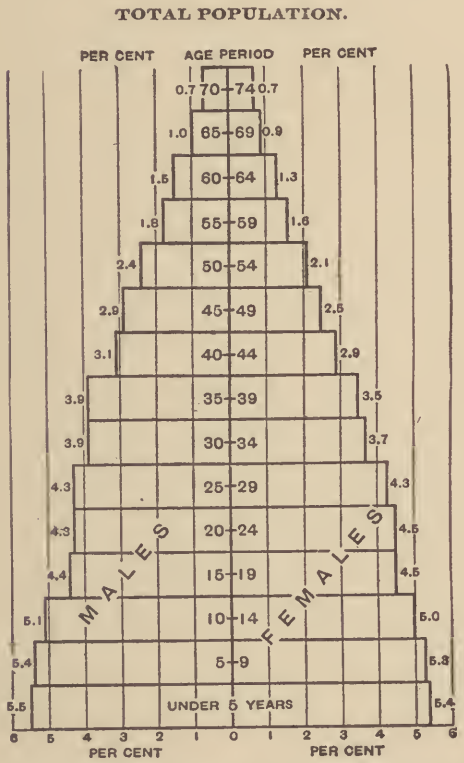


Fig. 5.—The distribution of males and females in the United States according to their ages: 1920 (from U. S. Census, 1920, Vol. II).

ferent localities. In the United States this is not true. The following table (10) gives some accurate data on age distributions in the United States.

TABLE 10

AGE AND SEX DISTRIBUTION (IN PERCENTAGE) IN THE UNITED STATES 1910 AND 1920

Age period,	1910			1920		
	Both sexes.	Males.	Females.	Both sexes.	Males.	Females.
All ages.	100.0	100.0	100.0	100.0	100.0	100.0
Under 5 years..	11.6	11.4	11.8	10.9	10.9	11.0
5– 9 years....	10.6	10.4	10.8	10.8	10.7	10.9
10–14 "	9.9	9.7	10.1	10.1	10.0	10.2
15–19 "	9.9	9.6	10.2	8.9	8.7	9.2
20–24 "	9.8	9.7	10.0	8.8	8.4	9.2
25–34 "	16.5	16.7	16.2	16.2	16.1	16.4
35–44 "	12.7	13.0	12.3	13.4	13.7	13.0
45–54 "	9.1	9.5	8.7	10.0	10.5	9.3
55–64 "	5.5	5.6	5.3	6.2	6.4	5.9
65–74 "	3.0	3.0	3.0	3.3	3.3	3.2
75+.....	1.1	1.1	1.3	1.3	1.2	1.4
Age unknown..	0.2	0.2	0.1	0.1	0.2	0.1

The data in Table 10 bring out a number of interesting facts about the structure of the population of the United States in 1910 and 1920. Thus, if the percentage distribution for "both sexes" is summarized in the following manner,

Percentage of population.	1910.	1920.
Under 20 years of age.....	42.0	40.7
20–44 years.....	39.0	38.4
45–74 "	17.6	19.5

it appears that certain important changes in the age distribution of the population occurred in the decade between the Thirteenth and Fourteenth Censuses. There were appreciable reductions in the proportion of persons under twenty years of age (1.3 per cent.) and twenty to forty-four years of age (0.6 per cent.) and an

increase in the proportion 45–74 (1.9 per cent.). This observation can be stated in terms of the median age of the population. It is found that the increasing

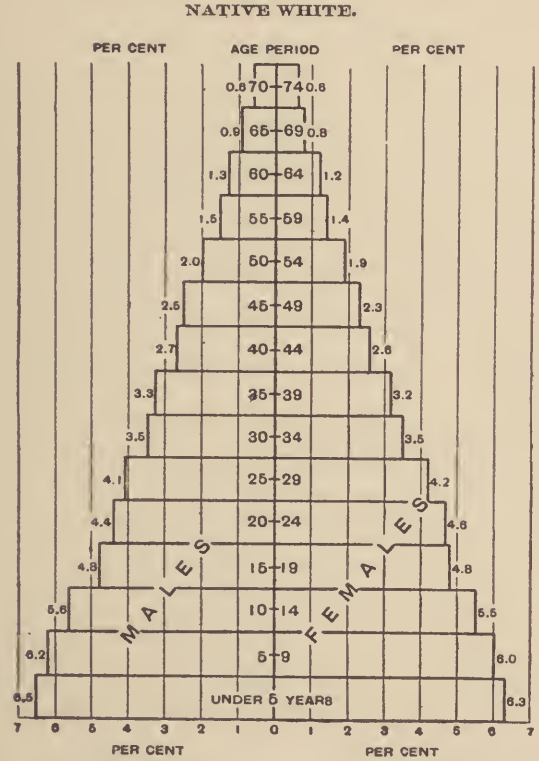


Fig. 6.—The age and sex distribution of the native-born white persons in the United States: 1920 (from U. S. Census, 1920, Vol. II).

proportion of older persons increased the median age[1]

[1] The *median age* is that age which divides the population into two equal groups, one-half being older and one-half younger than the median.

from 24 in 1910 to 25.2 in 1920. The same general tendency is evident among each of the sexes. (The median age for males increased from 24.6 to 25.8 and for

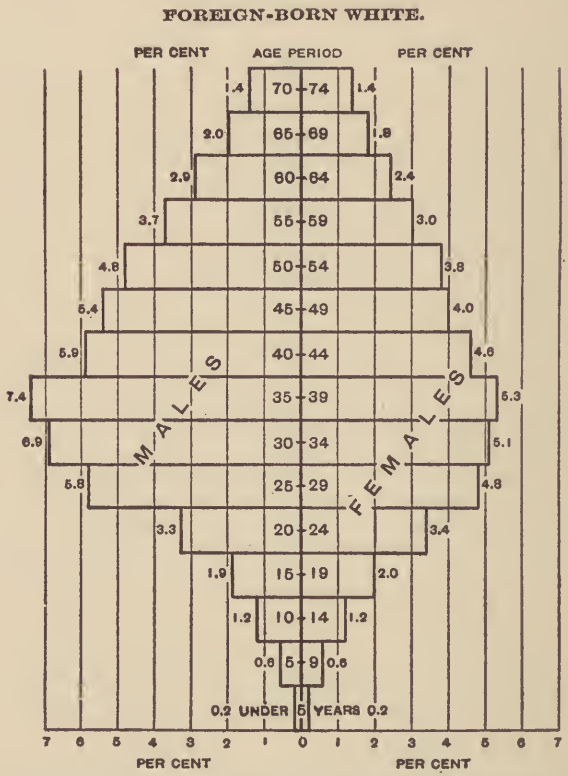


Fig. 7.—The age and sex distribution of the foreign-born white persons in the United States: 1920 (from U. S. Census, 1920, Vol. II).

females from 23.5 to 24.7.) Also, from Table 10, it is evident that a larger proportion of females than of males is in the younger ages of life.

In practical statistical work *refined* data on age distribution of a population must occasionally be taken with the proverbial grain of salt. Such information as the Census Bureau has collected is sufficiently accurate to serve in all but very precise statistical inquiries. It is open to criticism, however, because—as is well known—*age* information is sadly inaccurate at the very young and the very old ages, and somewhat inaccurate at all ages between. In studies which require information on the numbers of infants or centenarians, for example, the worker must apply to the Bureau of the Census for special corrected data, or must turn to other sources of statistical information.

CHAPTER III

BIRTHS AND BIRTH-RATES

Birth Control and the Population Problem.—Before 1914 and the beginning of the World War there was much argument whether the world was or was not suffering from population overcrowding. In the years which have elapsed since then Europe's toll of dead and incapacitated has freed it temporarily, at least, and in a small measure, from worries over the dire consequences of overpopulation. In the United States the problem has been subjected to more searching examinations than it had previously received. The propaganda of birth control partisans has helped particularly to rouse anew a public interest in the real facts about births.

"The birth-control movement assumes that the world suffers from overpopulation and that the first thing to do to put the world in order is to decrease the birth-rate. This is implied in everything that has been written by the advocates of birth control. The birth-rate is, after all, a relative value, and whether it is high or low depends upon a standard. A good fixed point for our discussion is such a birth-rate as will maintain the population at a fixed level, that is, neither increase it nor decrease it in the course of a generation. In a previous technical study of this question I have shown that, under present conditions of the death-rate, it

requires an average of close to 4 children per family to keep the population stationary. Two children reaching maturity are required to replace their parents, and because of the high mortality in infancy and early childhood and because so many people do not marry, it requires an average of nearly 4 children per completed family to make a new generation as large as the old. An average of 1, 2, or even 3 children per family, therefore, means a loss in population; an average of 5 or 6 children means an increase in the population.

"Do you know that the birth-rate in the United States is this year (1919) about what it was in France before the war? The birth-rate in New York is around 20 per 1000 of population. This represents a drop of about 20 per cent. in four or five years. The rate has been declining for a number of years, but never so rapidly as it has recently. We have now reached the point where one baby is born each year to every tenth family. Does this strike you as an excessive birth-rate? Do we need more birth control?" (Louis I. Dublin).

It is not an unfamiliar fact that in our every-day life we have grown accustomed to consider a family of 6 persons (2 parents and 4 children) as "large." Yet the statistical facts teach us that under the prevailing condition of mortality such 6 persons per completed family is only very slightly larger than that which is absolutely necessary to merely *maintain* the population without allowing for growth and increase. Also, it is a familiar fact that the larger families which we meet in communities in our country occur among the economically poorer portions of the popluation, and particularly among those who have only recently

immigrated into the United States. Special studies which have been made among many groups of persons, such as college professors, teachers in schools, business people of good position, and among large groups of the native-born population of native parentage, demonstrate an extraordinarily low average number of children for their completed populations. These classes of people in this country are not reproducing or maintaining themselves.

If any birth control is needed in the United States, it most assuredly is not among those classes of persons who are most easily reached by propaganda—the moderately well-to-do, healthy, productive groups whom we term our "middle class." And whether its propaganda shall be spread among the immigrant population and given public support is a question which is open to argument. The economic dangers which threaten a nation whose birth-rate is low must be weighed against the increased possibilities for higher development of individuals living under conditions of lessened family responsibilities and against the increased possibility for the maintenance of peaceful relations among the nations of the world.

Importance of the Birth-rate.—The births of this year give us the backbone of our population some twenty years hence. It is that portion of our population which falls within the ages of twenty and forty-five or fifty which is economically productive and virile. Ordinar-

ily, in the United States, this portion of the population constitutes some 40 per cent. of the total. The population under twenty makes up another 40 per cent., and that over fifty the remaining 20 per cent. Obviously, then, it takes only a single generation (twenty years) without births to convert a vigorous "young" population into a senile, decadent, "old" population. There are only two sources—birth and immigration—from which we can recruit the replacements for those who must grow old and feeble, and only one—births—by means of which we can maintain the native character of our population. Regardless of whether we favor great growth and increase in our population, regardless of whether we dream of imperial and international greatness—assuming only that we are working for the maintenance of our people as a healthy, vigorous race that can carry the traditions of the past into the future—we must toil for the maintenance of our birth-rate and for the preservation of our infants' lives after they are born.

Live Births and Still-births.—To obtain accurate statistics of births and birth-rates a number of standard procedures are followed in the United States. It has become customary to consider births in the following categories,

1. Live births: (*a*) At term.
   (*b*) Premature.
2. Still-births: (*a*) At term.
   (*b*) Premature.

and to use such classifications in technical, statistical studies. In most studies a *still-birth* is taken as the offspring of a conception which showed no signs of life at the time of birth. It is further restricted sometimes to those which have passed at least a six months' gestation period. *Unless otherwise stated, stastistics of births do not include still-births.*

The Importance of Birth Registration.—To the Health Officer the recording of births is a matter of great importance. If births are not registered how can he know with any degree of accuracy how many infants there are in his community; what proportion of the total is dying; at what age there is the highest mortality; in which seasons of the year his infant problems will be most acute? In such matters as concern the school officials, the legal requirements in marriage, voting, inheritance, legitimacy, etc., the importance of birth registration is every-day knowledge. And to the Public Health Nurse whose duties are now so closely bound up with maternal and infant welfare work—prenatal, natal, and postnatal—to the nurse who can accomplish some of her greatest humanitarian deeds in the saving of those infant lives which are needlessly sacrificed on the altars of Poverty and Ignorance, the registration of births is no mere bit of statistical formality. In many states the registration of a birth sets in motion a complex administrative organization which aims to safeguard the lives of the mothers and of their newborn children.

Complete and accurate registration is one of the starting-points in all public health work.

The recording of births as well as deaths is a state instead of a federal function. Experience has demonstrated that they are ideally recorded by a Bureau of a Department of Health. A Bureau of Vital Statistics should operate under the legal requirements of a Law for Vital Statistics.

The Registration Area for Births.—The Registration Area for Births (first organized in 1915) is now made up of about two-thirds of the population of the United States and includes those states in which 90 per cent. or more of the births are recorded. States are "admitted" into the Registration Area by the Census Bureau when they make adequate legal provision for birth registration, take adequate steps to enforce it, and when they demonstrate that they are recording at least 90 per cent. of their births. The area is growing from year to year.

The Model Vital Statistics Bill.—The Census Bureau has proposed a Vital Statistics Law which is the so-called Model V. S. Bill, and has recommended certain Standard Certificates of Births and of Deaths. The principal requirements of this model bill which pertain to births are the following:

1. Births shall be recorded by a State Department of Health.

2. The states shall be divided into primary registration divisions, with an official for each.

3. The Registrar shall be responsible for the enforcement of the law.

4. The birth of every child shall be recorded.

5. Registration shall occur within ten days of date of birth of each child.

6. It shall be the duty and function of the physician or of the person acting as midwife or parent to report the birth.

7. The use of the "Standard" birth certificate is recommended.

8. The certificate shall be returned to the proper authority.

The reasons for these provisions will readily occur to the reader. They are all designed fo facilitate the accurate and complete recording of births.

The principal items on the Standard Certificate of Birth concern:

1. Place of birth.

2. Name.

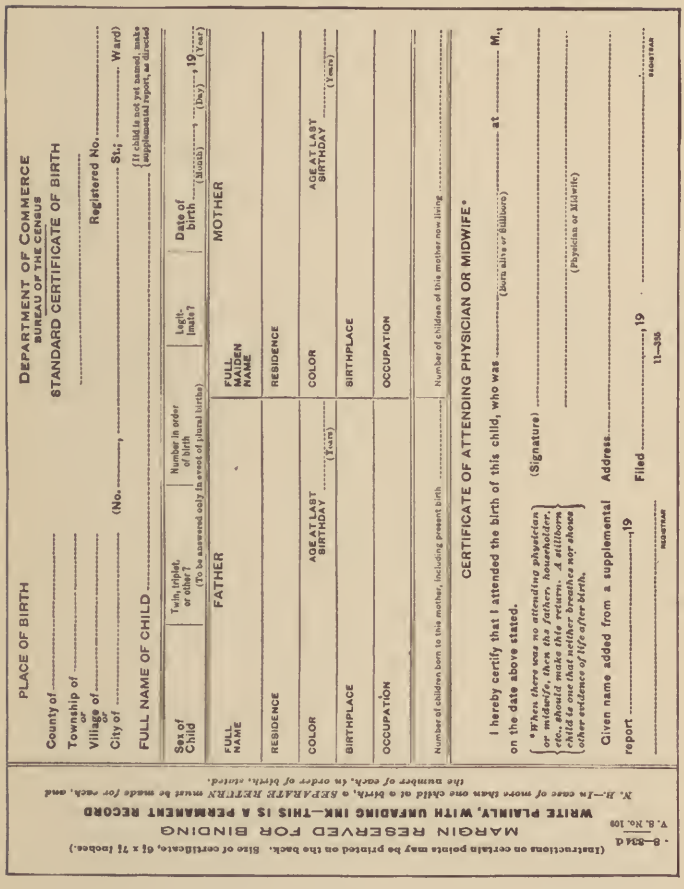
3. Sex.

4. Whether twin or triplet; number in order of birth; whether legitimate or illegitimate.

5. Date of birth.

6. Name, residence, color, age, birthplace, and occupation of father and of mother.

7. Total number and number living of children born to the mother.



PLACE OF BIRTH

County of .....

Township of .....

or

Village of .....

or

City of ..... (No. ....., ... St.; ..... Ward)

FULL NAME OF CHILD .....

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
STANDARD CERTIFICATE OF BIRTH

Registered No. .....

(If child is not yet named, make supplemental report, as directed)

Sex of Child	Twin, triplet, or other? (To be answered only in event of plural births)	Number in order of birth	Legitimate?	Date of birth (Month) (Day) , 19 (Year)

FATHER		MOTHER	
FULL NAME		FULL MAIDEN NAME	
RESIDENCE		RESIDENCE	
COLOR	AGE AT LAST BIRTHDAY ..... (Years)	COLOR	AGE AT LAST BIRTHDAY ..... (Years)
BIRTHPLACE		BIRTHPLACE	
OCCUPATION		OCCUPATION	
Number of children born to this mother, including present birth		Number of children of this mother now living	

CERTIFICATE OF ATTENDING PHYSICIAN OR MIDWIFE*

I hereby certify that I attended the birth of this child, who was ..... (Born alive or Stillborn) at ..... M.,

on the date above stated.

(Signature) .....

(Physician or Midwife)

*When there was no attending physician or midwife, then the father, householder, etc., should make this return. A stillborn child is one that neither breathes nor shows other evidence of life after birth.

Given name added from a supplemental report ....., 19

Address .....

Filed ....., 19

REGISTRAR

11—355

REGISTRAR

(Instructions on certain points may be printed on the back. Size of certificate, 6½ x 7½ inches.)

8—834 d
V. S. No. 109

MARGIN RESERVED FOR BINDING

WRITE PLAINLY, WITH UNFADING INK—THIS IS A PERMANENT RECORD

N. B.—In case of more than one child at a birth, a SEPARATE RETURN must be made for each, and the number of each, in order of birth, stated.

Fig. 8.—The standard birth certificate.

8. Certification of the attending physician or midwife, stating whether the child was live or still-born.

This certificate is filed by the Registrar of the community as a permanent record.

The Adequacy of Birth Registration.—Some years ago Dr. Dublin, of the Metropolitan Life Insurance Company, suggested the following tests for the adequacy and completeness of birth registration in a community: 1. In practically all normal communities in which there is complete (or nearly complete) registration of births, the number of these recorded in a year exceeds the number of children under one year of age. This relation should hold if birth registration is adequate. It is reversed if inadequate. 2. In a normal population the birth-rate (the proportion of births to population) should remain nearly stationary from year to year. 3. The birth-rate should exceed a certain minimum (about 20–25 per 1000 population).

Birth-rates.—Relating births to the total population[1] gives what is termed the "crude" birth-rate.

$$\text{Birth-rate per 1000} = \frac{\text{Number of births}}{\text{Population}} \times 1000$$

From practical experience most of us know that the birth-rates vary for different racial groups in the population. Even within a single racial group, however, the birth-rate will vary with the age distribution of the population. Quite obviously it will vary also with the sex distribution. The birth-rate is dependent upon

[1] It is important to remember that for accurate calculation the *mid-year* population must be used.

the fecundity of the *female* population of the *child-bearing ages* (ordinarily taken for statistical purposes as 15 to 45 years). If females of theses ages are sparse in a population the crude birth-rate will obviously be very low. If they are unusually numerous, the rate will be high.

Therefore, to get more accurate birth-rates the ratio $\frac{\text{Births}}{\text{Population}}$ is restricted (or "refined") to $\frac{\text{Births}}{\text{Female population}}$ and still further to $\frac{\text{Births}}{\text{Female population fifteen to forty-five years}}$. This last is the so-called "true" birth-rate. To differentiate between legitimate and illegitimate births—a distinction which is not very important in the United States—the calculation of rates is further restricted to married females and to unmarried females, *i. e.*,

$$\text{Legitimate birth-rate} = \frac{\text{Legitimate births}}{\text{Married females 15–45 years}} \times 1000$$

$$\text{Illegitimate birth-rate} = \frac{\text{Illegitimate births}}{\text{Unmarried females 15–45 years}} \times 1000$$

How these various birth-rates vary in a single community is indicated by the following figures for Kensington, England, compiled by Dr. Newsholme:

Crude birth-rate—21.8 births per 1000 inhabitants.
True birth-rate—61.6 births per 1000 women aged fifteen to forty-five years.
Legitimate birth-rate—215.4 births per 1000 married women aged fifteen to forty-five years.
Illegitimate birth-rate—4.68 births per 1000 unmarried women aged fifteen to forty-five years.

In most communities abroad the illegitimate birth-rates are of considerably greater importance than in the United States.

In that portion of the United States in which birth registration is complete (Registration Area for Births) there were recorded in 1920 a little more than 1,500,000 births. This area contained 60 per cent. of the total population of the country. Hence we may estimate that there were in the United States in that year approximately 2,500,000 births. This means a birth-rate for the country of 23.7 (births per 1000 persons in the population).

The Trend of the Birth-rate.—The birth-rate varies in different parts of the country. Even in any one geographical part there are differences between the birth-rates for the urban and the rural populations. In Table 11 the figures are given for the urban and rural portions of the Registration Area for Births.

TABLE 11

URBAN AND RURAL BIRTH-RATES. UNITED STATES REGISTRATION AREA FOR BIRTHS: 1915–1921[1]

Year.	Urban.	Rural.	Total.
1915	26.0	23.7	25.1
1916	26.0	23.5	25.0
1917	25.4	24.0	24.7
1918	25.1	24.0	24.6
1919	22.7	22.0	22.3
1920	23.8	23.6	23.7
1921	....	....	24.3

[1] Exclusive of still-births.

These figures indicate the decline in the rate which occurred in the years 1915–1921. (There has appeared a small increase in 1920 and 1921 over the 1919 rate.) Further, they show that although there was practically no difference between the urban and rural birth-rates in 1920, there had been real differences—uniformly an excess in the urban areas—in the five years preceding 1920. This excess is probably associated with differences in the race and age proportions of the two populations.

Birth-rates and the Race and Nativity of the Mother.—Because of the inaccuracies in the estimation of populations in intercensus years birth-rates for the white and colored races are not known precisely for the years during which the Registration Area for Births has been in existence (1915 to date). In 1920, when there were 23.7 births for each 1000 persons, there were 23.5 for each 1000 white and 27 for each 1000 colored persons.[1] The indications are that the differences between the two are comparatively small. The proportions of births among whites of native, foreign, and mixed parentage and among the colored populations are indicated in Table 12 on page 64.

These figures indicate that three-fifths (60 per cent.) of all births in the United States occur among white persons born in this country, and that one-third (33

[1] These figures were calculated from estimated midyear populations based upon the census data for 1910 and 1920.

TABLE 12

RELATION BETWEEN RACE AND NATIVITY AND BIRTH-RATES. UNITED STATES REGISTRATION AREA: 1919

	Number of births.	Percentage of total.
Total population	1,373,438	100.0
Total white	1,269,363	92.3
White, of native parentage	816,546	59.4
White, of mixed parentage	141,508	10.3
White, of foreign parentage	310,540	22.6
Negro	95,516	7.0
Other colored	8,559	0.6

per cent.) of the children are born to parents one or both of whom were born in some foreign country.

For some years increasing attention has been focussed upon the problem of whether the native race stocks of this country are or are not maintaining themselves, or whether they are being replaced by the immigrant races. The discussion has concerned itself in a measure with the studies of the birth-rates of native-born and of foreign-born women, and of the increasing proportion of persons of foreign birth in our population. In Table 5 a group of figures was presented which indicated that between 1850 and 1910 the foreign-born whites had increased from 11.5 to 16.3 per cent. of the total white population. This excessive increase of foreign-born whites over native-born whites is of necessity ascribed to the extensive immigration of foreign-born persons. The higher birth-rate of the foreign-born than of the native-born in this country accounts for the maintenance of the native-born stock of foreign

parentage. (See Table 5.) The data in Table 13 are taken from a study by P. R. Eastman of the births which occurred among white mothers in New York State (exclusive of New York City) in 1916 according to the nativity of the mothers.[1]

TABLE 13

BIRTHS AMONG WHITE MOTHERS OF DIFFERENT NATIVITIES, NEW YORK STATE: 1916

Nationality or nativity of mother.	Births per 1000 persons.
Total white	22.1
Native white	17.2
Foreign-born white	43.8
English, Scotch, and Welsh	19.1
Irish	15.1
German	14.1
Italian	91.6
Russian	88.6
Austro-Hungarian	89.9
Canadian	21.3
Other foreign born	30.8

They indicate clearly that the native-born population is not reproducing itself as rapidly as the foreign-born population residing in the same state. In fact, the rate of reproduction as evidenced by these crude birth-rates is twice as high for the foreign as for the native born. If it were pertinent to this discussion statistics could be presented to indicate that the Italian, Russian, and Austro-Hungarian groups in New York State, for example, are probably reproducing themselves with

[1] In this table nativity designations are used in terms of their prewar significance.

even greater rapidity than are groups of similar nativity residing in their native countries.

Birth-rates and Economic Factors.—It is a common belief among laymen as well as among statisticians that birth-rates are higher among families of the lower

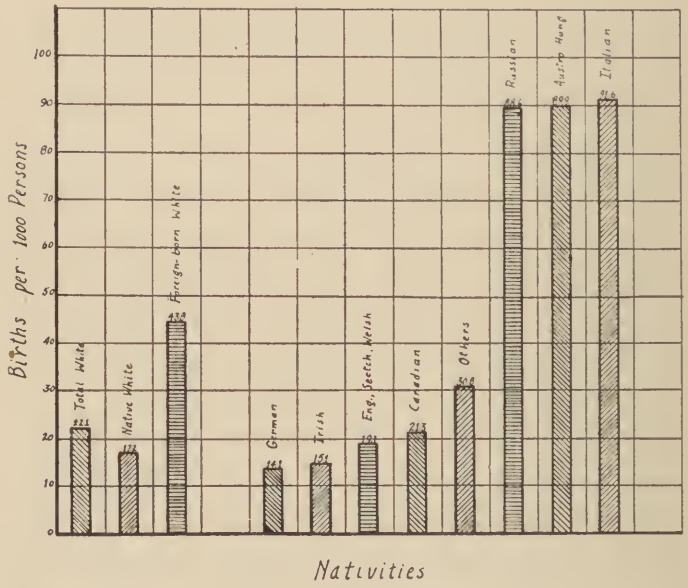


Fig. 9.—Birth-rates among persons of different nativities residing in New York State in 1916 (Eastman).

than of the higher social and economic classes. Accurate statistical proof for this belief is not readily or easily obtainable. The population of the higher social position are commonly made up of larger proportions of older persons and hence a lower birth-rate among them may

at least partly—if not largely—be an association with the lower fecundity of older persons generally. The foreign-born persons who reside in New York State and who have comparatively high birth-rates are, on the whole, poor people of lower social standing. It appears reasonable to believe that their excessively high birth-rates in this country would not be so much higher than birth-rates of native-born groups if the latter, for this comparison, were chosen from the economically poorer strata of the whole native population. However accurate or inaccurate these associations and explanations may be, they do not alter the fact, evidenced by numerous statistical studies, that the foreign born are reproducing more rapidly than the native born. This greater tendency to increase is offset in a certain measure among certain foreign-born groups by their higher death-rates.

Relation Between the Female Population and the Birth-rate.—The influence of the sex distribution of a population upon its birth-rate needs scarcely any explanation. Except in an ultimate analysis birth-rates are dependent upon the number of females of child-bearing ages in the population. In comparing rates for different places and for different times variations in sex distribution are corrected by recourse to the refined birth-rates described earlier in this chapter. Similarly, age distribution affects the birth-rates of populations. Even within the statistical ages of child-bear-

ing (fifteen to forty-five years) appreciable variations in fecundity occur. It has been found that of a thousand births taken at random in a community, less than 6 per cent. occur among mothers under twenty years of age, 26 per cent. among mothers twenty-four to thirty, and 42 per cent. among mothers thirty to fifty. Among a thousand mothers of each age group there are appreciable differences in fecundity. Other things being equal, a population with an excessive proportion of women twenty to thirty years of age will have an unusually high birth-rate.

Seasonal Fluctuations in Births.—For a single community births occur more frequently in certain months of the year than in others. In New York City, for example, the birth-rate per month is higher in January, February, and March than in any other months of the year. This relation may or may not be true in cities in warmer or colder parts of the country. It is generally true in any community, no matter where located, that births are most frequent nine months after the period of highest frequency of marriage. The seasonal variations of birth occurrence should hold a real importance in the minds of health administrators and field workers. The public health nurse who is doing generalized or specialized nursing, for example, should be prepared for a special siege of maternal and infant welfare work in those months of the year in which the greatest number of births occur.

In Chapter II mention was made of the fact that there are more males born than females, and that the ratio is generally about 105 males to 100 females. Although the exact excess of males differs for different races and from time to time, it appears to occur universally.

Trend of the Birth-rate.—It had been customary in the United States for statisticians to look for a birth-rate of approximately 25 per 1000 as the normal, the average for an average mixed population. Unless unusual proportions of foreign or native groups existed in a community, a birth-rate lower than 25 was viewed with suspicion, and examined for inaccuracies either in the registration of births or in the estimation of the population. It had been known, even before 1910, however, that a real decline in the birth-rate has been occurring. The data presented above in Table 11 illustrate further that this decline has been continuous down to 1920. Indeed, it is no difficult task to demonstrate that in all countries in which reasonably accurate statistics are available, Germany alone excepted, there had been a slight or a marked decline in the birth-rate in the seventy-five-year period between 1840 and 1915. In Table 14 (page 70) the trend of the birth-rate is illustrated for the United States, as represented by Massachusetts, for Great Britain, France, and Germany.

It is significant to note that the downward trend of the birth-rate has continued in its course with scarcely

TABLE 14

TREND OF THE BIRTH-RATE IN MASSACHUSETTS AND IN CERTAIN FOREIGN COUNTRIES. BIRTHS PER 1000 PERSONS IN THE POPULATION

Years.	Massachusetts.	Great Britain.	France.	German Empire.
1841–1850	....	....	27.4	36.1
1851–1860	....	....	26.3	35.3
1856–1860	29.5	....	....	...
1861–1870	....	....	26.3	37.2
1866–1870	26.1	....	....	....
1871–1880	....	....	25.4	39.1
1876–1880	24.3	35.3	....	....
1881–1890	....	....	23.9	36.8
1886–1890	25.9	31.4	....	....
1891–1900	....	....	22.2	36.1
1896–1900	27.0	29.3	....	....
1906–1910	....	26.3	....	....
1916–	25.1	24.4	....	....

any interruptions despite the fact that the improvements in birth registration have tended continually to make the figures comparatively higher in the later than in the earlier years. (In Germany the birth-rate was 34 in 1905; 31 in 1910; 28 in 1914—at the beginning of the war; 15 in 1918; 27 in 1920, and 26 in 1921.)

When the birth-rate of a nation declines the influences upon the characteristics of the population are profound. Generally it remains higher than the death-rate, even if only by a small margin. When it comes to be lower than the death-rate, the population is dying out, unless the excess of deaths over births is counterbalanced by an excess of immigration over emigration. When the birth-rate is high, and particularly when the death-rate is low, the population is growing rapidly and vigor-

ously—vigorously, because in this event a large birth-rate means a large proportion of young persons in the community. Conversely, a low birth-rate means a numerically stagnating population with a relatively large proportion of old persons. The influence of the birth-rate which prevailed in Great Britain, France, and Germany in the nineteenth century upon their populations is indicated in Table 15.

TABLE 15

GROWTH OF POPULATION IN FRANCE, GREAT BRITAIN, AND GERMANY

Country.	1800.	1899.
France	29,000,000	39,000,000
Great Britain	18,000,000	45,000,000
Germany	23,000,000	65,000,000

Thus, under the operation of higher rates of reproduction and lower rates of mortality, in the period of one century Germany grew to have one and two-thirds, although it had started with only four-fifths, the population of France. Further, Germany had grown to have a larger percentage of youthful persons, France a large proportion of old adult persons. There can be no doubt that up to the time of the war the German mothers represented a more active and more successful machine for reproduction than the French, English, or American mothers. The influences of this superiority upon the peace and happiness of the world have been history now for nine years.

CHAPTER IV

INFANT MORTALITY

More than twenty years ago a distinguished sanitarian, Sir Arthur Newsholme, wrote: "Infant mortality is the most sensitive index we possess of social welfare and of sanitary administration, especially under urban conditions." The passage of two decades has not altered the truth of his assertion. Even today it is to the health propangandist what the clinical thermometer is to the physician. Childhood is ushered in with the highest and out with the lowest rates of mortality of all the span of life. Coupled with its enormous severity, infant mortality bears the additional characteristic that —like the thread of mercury in the thermometer—it goes up and down with deleterious or salutary changes in the social, sanitary, and economic conditions of the people. Poverty, ignorance and sickness, and the immediate and remote causes of infant deaths play their hands in partnership against the community, each aiding and abetting the others. Where one leaves off the others begin, and the toll of infant deaths runs apace with their play. A healthy crop of infants today provides a vigorous harvest of adults when the time of a generation has passed by. Sanitation practically applied

must take for one of its chief goals the safeguarding of infant lives.

Definitions. The Infant Mortality Rate.—In vital statistics the term "infant" is applied to a child from the day of its birth up to the end of its first year of life. In studies of mortality of a population it is customary to use *death-rates, i. e.*, the ratio between deaths and the population, which are expressed as so many deaths per 1000, per 10,000, or per 100,000 persons. In problems which concern themselves with specific populations, such as special age, sex or race groups, we employ *specific death-rates, i. e.*, the ratio of deaths in the specific group to persons in the same group. In this manner the logical index of infant mortality would be the specific death-rate of infants. This would be calculated by substituting the appropriate figures in the formula:

$$\text{Specific death-rate of infants} = \frac{\text{Deaths under one year of age}}{\text{Population under one year of age}} \times 1000$$

In point of fact, however, the specific death-rate of infants is not used to any great extent because of the difficulties inherent in counting the infant population accurately. A census, when taken, makes a count of infants living on a single day or week. But births vary considerably from month to month during the year. A further error creeps into census estimations of infant populations because ages of infants are so often given incorrectly to enumerators. Therefore, instead of the

specific death-rate, the *infant mortality rate* is employed in statistical estimations. This is an expression of the number of deaths of infants per 1000 *births*, and is readily calculated from the following formula:

$$\text{Infant mortality rate} = \frac{\text{Deaths under one year of age}}{\text{Births}} \times 1000$$

Both deaths and births are taken exclusive of still-births.

The rate thus obtained is not without its inaccuracies. In a great many communities birth reporting is notoriously bad, and hence the denominator in the fraction above is subject to appreciable error. The larger the error in the number of recorded births—the error due to failure to report births—the larger the infant mortality rate will be. This is in accordance with the general principle in arithmetic that the smaller the denominator of a fraction, the larger is the value of the fraction. Hence without saving a single infant life it is possible to lower the infant mortality rate by improving birth registration. This statistical fallacy must be carefully avoided by the health officer or nurse who attempts to evaluate the accomplishment of an infant welfare campaign.

Still-births.—The occurrence of prenatal deaths complicates the calculation of infant mortality. What shall be done with these deaths? If they are counted in with infant deaths they must also be counted with the births. Even this is an unsatisfactory arrangement.

In practice it has been found advisable to observe the following rules: Fetal deaths which occur before the sixth or seventh month of gestation shall be known as miscarriages and shall not be reportable or recognized in the statistical work; those which occur later than the seventh month shall be known as still-births and shall be reported as such. The records of still-births shall always be kept apart from the true births and from the deaths of other infants. If they are included with all infant deaths special statement to that effect shall be made.

At Johnstown, Pa. (1915), 4.5 per cent. of all births were still-births and 8.7 per cent. of all mothers included in the survey made by the Children's Bureau had suffered miscarriages. The relation between the occurrences of still-births and the age of the mother was striking. The findings are presented in Table 16.

TABLE 16

STILL-BIRTHS, BY THE AGES AND NATIVITY OF MOTHERS, JOHNSTOWN, PA., 1915

Age of mother.	Still-births—per cent. of all births.
–20 years	11.1
20–24 "	4.0
25–29 "	5.1
30–39 "	4.4
40+ "	3.3
Native mothers	5.2
Foreign mothers	3.8

The figures indicate that still-births occur more frequently among native-born than among foreign-born

mothers, and more commonly among young than among old mothers. Indeed, a high still-birth rate is intimately associated with first pregnancies. In a recent publication Dr. W. T. Howard, Jr., has indicated that for the mixed population of the United States Registration Area for Births there were (in 1918) about 3.5 still-births for each 100 total births, about 6 still-births per 100 births among white persons, and about 13 per 100 births among negroes in Baltimore (1915–19). Using the 3.5 per cent. figure, we calculate that for the 2,500,000 births which occur annually in the United States there are approximately 75,000 still-births. It is not yet certain *to what degree* high still-birth rates are associated with poor obstetric service and to lack of prenatal education, and to what measures we must resort to reduce them.

Sources of Infant Mortality Data.—The chief sources of statistical data on problems of infant mortality are: the weekly, monthly, and annual reports of city and state departments of health, the annual reports on Birth Statistics and Infant Mortality for the United States Registration Area (issued by the Census Bureau, Washington, D. C.), the publications of the Children's Bureau, the reports of special surveys by municipal or private agencies, the reports of Visiting Nurse Associations, the publications of the American Child Hygiene Association, etc. Practically all of these are easily obtainable upon request from the appropriate officials.

Extent and Trend of the Infant Mortality Problem.—In 1919 the Registration Area for Births of the United States comprised about 60 per cent. of the country's population. In this group there occurred a little less than 800,000 deaths. Of these, nearly 120,000 were deaths of infants. That is the basis of infant mortality problem in this country—120,000 infants died of 1,400,000 born! Nearly 9 per cent. (86 per 1000 births) of all the newborn did not live to celebrate their second birthday!

The extent of the problem and its trend since 1915, the year of establishment of the Registration Area, is given in Table 17,

TABLE 17

INFANT MORTALITY IN THE UNITED STATES REGISTRATION AREA FOR BIRTHS, 1915–1921

	Deaths of infants per 1000 births.						
	1915.	1916.	1917.	1918.	1919.	1920.	1921.
Registration area, total..	100	101	94	101	87	86	76
White persons.....	99	99	91	97	83	82	
Colored persons.....	181	185	151	161	131	132	

and for Massachusetts and Boston, for which reasonably accurate figures are available as far back as 1908, in Table 18 (page 78).

These figures indicate that although infant mortality has been decreasing quite regularly year by year, it is still unsatisfactorily high. An infant mortality rate of 100 means one infant death among each 10 births. And that is a high figure regardless of whether it is

TABLE 18

INFANT MORTALITY IN MASSACHUSETTS AND BOSTON, 1908–1921

Year.	Infant deaths per 1000 births: Massachusetts.	Boston.
1908	134	149
1909	127	121
1910	133	127
1911	119	126
1912	117	117
1913	110	110
1914	106	105
1915	101	103
1916	100	105
1917	98	99
1918	113	115
1919	88	97
1920	91	101
1921	...	77

two-thirds, one-half, or one-third of the infant mortality rate of twenty years ago.

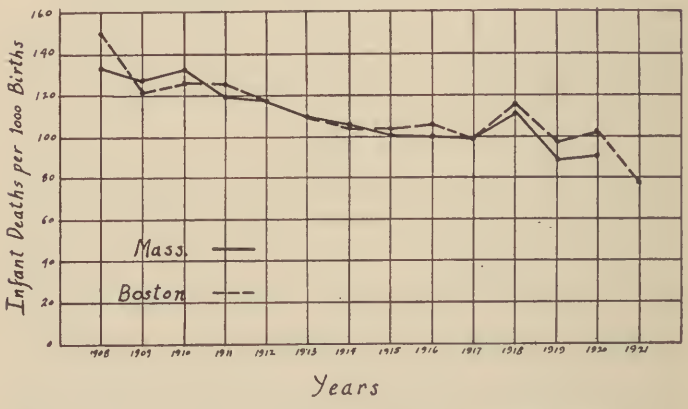


Fig. 10.—The declining infant mortality in Massachusetts and Boston in the years 1908–1921.

Variations in Infant Mortality Rates.—Striking differences are met with when comparison is made between the infant mortality rates for different communities. Thus in Brookline, Mass., the rate for 1919 was 53 and for 1920 was probably 34; for New York City, 81 in 1919, and approximately 85 in 1920; and for New Bedford, Mass., 122 in 1919 and 117 in 1920. Professor Raymond Pearl, of the Johns Hopkins School of Hygiene and Public Health, has shown recently that these variations between city and city are due chiefly to variations in the mortality caused by *preventable* causes of infant death. There is every reason to believe that sanitary knowledge already available would, if applied, bring infant mortality rates down to 40 or 50 in any community of average social and racial composition. Infant deaths above this rate mean necessity and opportunity for health workers.

In Table 19 some data are presented from a recent compilation of available statistics upon infant mortality

TABLE 19

THE MORTALITY OF MALE AND FEMALE INFANTS IN CERTAIN COUNTRIES

Country.	Year.	Infant deaths per 1000 births: Males.	Females.
New Zealand	1918	54	43
Netherlands	1919	55	44
United States	1919	96	77
England and Wales	1919	100	78
German Empire	1914	177	149
Chile	1918	261	248
Russia	1909	265	237

in certain foreign countries. Of course, many of the figures are far from precise and, indeed, are only approximately accurate. However, they show clearly enough the huge differences in infant mortalities which are known to occur throughout the countries of the world.

Such huge differences as existed between Chile, on the one hand, and New Zealand, on the other (comparing corresponding rates for 1918), are very powerful arguments for the strongest application of sanitation in a community. In 1918 of every 40 children born in Chile 10 died during the first year of life; in the following year (1919) of every 40 born in the United States less than 4, and in the Netherlands only 2, died before the first anniversary of their birthdays. In Chile each infant born in 1918 had five times as many chances to die in the first year of life as did an infant born the following year in the Netherlands!

The Chief Causes of Infant Deaths.—To obtain a correct understanding of the infant mortality problem it is essential to have clearly in mind the causes of infant deaths. Only when we know accurately these causes can we apply campaign methods to aid in their prevention. In a study made in Boston (L. I. Dublin) it was found that the deaths from congenital debility, diarrhea and enteritis, and the penumonias made up practically three-quarters of the total deaths. A field study of infant mortality in Manchester, N. H. (Duncan and Duke, 1917), made under the auspices of the

Children's Bureau of Washington, D. C., showed the same result. The gastro-intestinal diseases caused 38 per cent. and the diseases of early infancy (premature birth, congenital debility, and malformations) another 30 per cent. of all deaths. When to these two groups of causes of infant death are added the respiratory diseases we have 80 per cent. of the total accounted for. These relationships of the principal causes of infant deaths are general.

Two years ago Professor C.-E. A. Winslow pointed out that although the campaign against infant mortality has achieved brilliant success, its accomplishments have been limited to certain causes of death and have left certain others untouched. Table 20 is compiled from his paper.

TABLE 20

THE MORTALITY OF INFANTS FROM CERTAIN CAUSES. UNITED STATES REGISTRATION AREA FOR DEATHS: 1910–1918

	Infant deaths per 1000 infants								
	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
Diarrhea and enteritis....	37.7	29.0	26.2	28.1	24.7	22.6	24.1	23.2	22.2
Certain other causes.....	40.5	43.1	44.3	46.2	45.0	43.4	43.4	42.6	43.6
Malnutrition.....	6.6	6.4	6.5	6.8	7.3	6.9	7.5	7.5	7.5
Premature birth.....	17.5	18.4	19.1	20.0	20.1	20.3	21.2	21.1	22.1
Congenital debility....	13.2	14.6	15.0	15.5	13.4	11.9	10.3	9.4	10.1
Injuries at birth.....	3.2	3.7	3.7	3.9	4.2	4.3	4.4	4.6	3.9

"The death-rate from diarrhea and enteritis has been reduced from an average of 31 for 1910–12 to an average of 23.2 for 1916–18, a saving of 7.8 lives per 1000. On the other hand, the combined death-rate from malnutrition, premature birth, congenital debility, and injuries at birth has increased from an average of 42.6 for 1910–12 to an average of 43.2 for 1916–18. The

intestinal disorders which prevail for the most part from the third month of life are yielding to preventive measures, but the causes of mortality which operate at birth and during the first month have continued to operate unchecked.

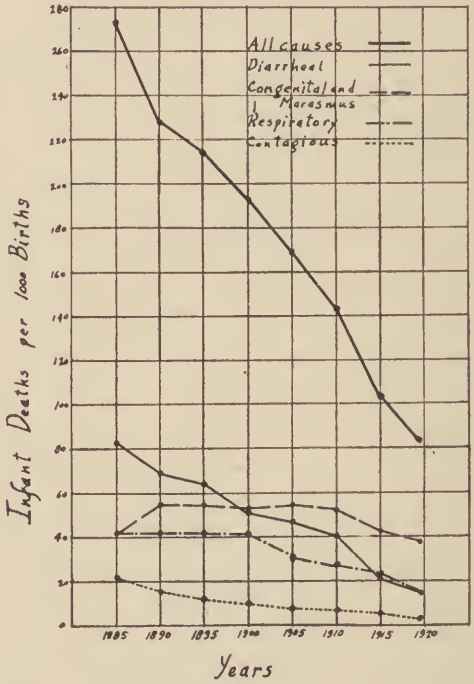


Fig. 11.—The decline in infant mortality from certain causes in Manhattan and the Bronx: 1885–1919 (Meyer).

"It is this fact which has made it clear that the machinery of medical examination and hygienic supervision must be extended backward to include the expectant mother, and the experience of the prenatal clinics in Boston and New York have shown that the

mortality of the first month is quite as amenable to preventive measures as that of the later months of infant life. The ratio of still-births to living births has been reduced in Boston to 1 per cent. for cases with prenatal care, as compared with 3.4 per cent. for the population as a whole; and the mortality of infants in the first two weeks of life has been reduced to 11.9 per cent., as compared with 34.2 per cent. for the population as a whole" (C.-E. A. Winslow).

Between urban and rural communities there are no striking differences either in the severity of infant mortality or in the causes of death. Between the white and the colored there are real differences. The greater mortality among negro infants is indicated by the high rates of Table 17 (see p. 77).

The Ages of Infants at Death.—Numerous studies have indicated that the greatest mortality of infants occurs in the first day of life; taken by weeks, is highest for the first week; and taken by months, is highest in the first month of life. These facts become clear in the light of the large rôle of congenital debility, icterus, and sclerema as causes of infant deaths. These causes operate very shortly after birth. Any welfare work that is directed against these causes must operate either in the prenatal or in the earliest postnatal periods. It is not unusual for one-half to two-thirds (67 per cent.) of all infant deaths in a community to occur in the first quarter of the first year of life.

TABLE 21

THE DEATHS OF INFANTS ACCORDING TO AGE AT DEATH. UNITED STATES REGISTRATION AREA FOR BIRTHS, 1919

Age at death.	Infant deaths per 1000 births.
Under 1 day	14.5
1 day	4.5
2 days	3.4
3–6 days	6.3
1 week	5.9
2 weeks	3.8
3 weeks	3.1
Total under one month	41.5
1 month	7.3
2 months	5.9
3– 5 months	13.7
6– 8 months	10.3
9–11 months	7.9
Total under one year	86.6

The Seasonal Distribution of Infant Deaths.—The seasonal variations in the severity of infant mortality go hand in hand with the relation between season and the three principal groups of causes of infant deaths discussed above. Congenital debility, icterus and sclerema, congenital malformations, premature birth, injuries at birth, etc.—those causes which are most intimately concerned with the infants' heredity and the prenatal and natal conditions of the mother—take their toll of infant lives regardless of the season. Diarrhea and enteritis get in their most effective licks in July, August, September, and October; the respiratory

diseases, theirs in December, January, February, and March. These seasonal correlations are indicated in the infant mortality rates for all causes of death when subdivided for each month of the year.

TABLE 22

INFANT MORTALITY AND MONTHS OF THE YEAR. UNITED STATES REGISTRATION AREA FOR BIRTHS, 1919

Months of year.	Infant deaths per 1000 births.
January	10.3
February	9.8
March	11.1
April	8.4
May	7.6
June	6.6
July	7.9
August	8.2
September	7.6
October	7.7
November	7.0
December	7.7
Average per month	8.3

Accordingly, one observes in Table 22 and in Fig. 12 two high points for infant mortality, one in the winter months and one in the middle of the summer.[1] In the spring and fall months the rates decline to their minima. An adequately designed infant welfare program utilizes these facts. The dictates of common sense demand that attention shall be focussed upon avoidable infant mortality when it is unduly high.

[1] The progressive diminution in the "summer peak" to the stage illustrated in Fig. 12 marks one of the great accomplishments of the public health campaign.

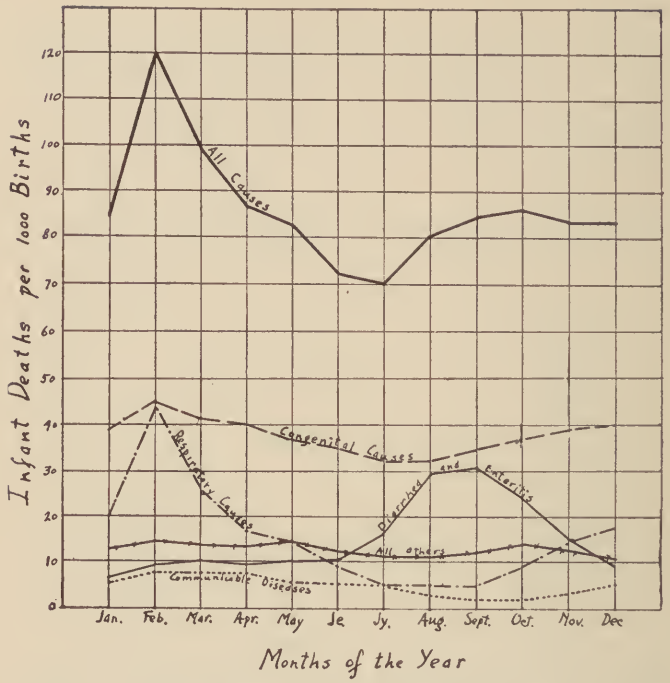


Fig. 12.—The distribution of infant deaths from certain causes according to the months of occurrence (U. S. Registration Area for Births, 1920[1]).

[1] *Curve:*	*Includes deaths from:*
1. "All Causes."	All causes.
2. "Diarrhea and Enteritis."	Diarrhea and enteritis.
3. "Congenital Causes."	*a.* Congenital debility.
	b. Injuries at birth.
	c. Premature birth. *d.* Malformations.
4. "Respiratory Causes."	*a.* Tuberculosis of the lungs.
	b. Acute bronchitis.
	c. Pneumonia. *d.* Influenza.
5. "Communicable Diseases."	*a.* Measles.
	b. Scarlet fever. *d.* Diphtheria and croup.
	c. Whooping-cough. *e.* Erysipelas.
6. "All Others."	All other causes.

Infant Mortality and Type of Feeding.—To illustrate the correlation between infant mortality and various racial, social, and economic factors is a comparatively simple matter. Statistical evidences of many kinds are available. We may instance a single example. Dr. Woodbury, of the Children's Bureau, United States Department of Labor, recently compiled the results of eight studies which bear upon the relation between infant feeding and mortality. The data in the following table (23) are taken from his report.

TABLE 23

INFANT MORTALITY AND TYPE OF FEEDING. INFANTS IN EIGHT CITIES

Month of life.	Deaths each month per 1000 infants			
	All types of feeding.	Breast fed.	Partly breast fed.	Artificially fed.
First	21.5[1]	16.9	36.4	54.7
Second	9.3	5.8	14.7	24.6
Third	8.1	3.7	12.9	21.2
Fourth	8.0	3.4	9.0	19.2
Fifth	7.7	3.3	5.7	18.1
Sixth	7.4	2.1	5.9	17.7
Seventh	6.3	1.9	4.0	14.1
Eighth	5.8	2.9	3.3	11.3
Ninth	5.7	3.2	2.9	10.7
Tenth	5.3	3.8	2.3	9.3
Eleventh	3.9	2.4	2.5	6.0
Twelfth	4.5	4.4	2.7	6.4

It appears from these figures that in the first six or seven months of life breast-fed infants show markedly lower mortality rates than partly breast-fed or artificially fed infants. After the seventh month the differences become progressively smaller, but in every case

[1] Exclusive of deaths among infants which died before first feeding.

the artificially fed infants die in greater proportions than the breast fed. Dr. Woodbury has calculated from his data that had the death-rates of the breast-fed infants occurred among those which were artificially fed, instead of 1047 deaths in the latter group there would have been only 269!

Further, he says, "When the comparison is limited to the first nine months of life, however, the excess mortality both among artificially and among partly breats-fed infants appears more marked. Thus, during the first nine months 870 deaths of artificially fed infants occurred, as compared with only 181.3 that would have been expected at the rate of mortality prevailing among breast-fed infants. In other words, during this period the rates of mortality among the artifically fed averaged nearly five times as high as among the breast-fed infants. Among the partly breast-fed infants 201 deaths occurred during the first nine months, as compared with only 109.3 deaths expected on the basis of the rates prevailing among breast-fed babies. The monthly death-rates among the partly breast-fed babies averaged, therefore, not quite twice as high as those among the more favored group of infants who received breast feeding."

In his conclusion Dr. Woodbury stated "that artificial feeding, as actually practised in typical city populations, is associated with a mortality between three and four times as high as the mortality among breast-

fed infants." Further, it appeared that these relations are not dependent upon the nationality of the mother or the earnings of the father, although these latter indications were not conclusive.

The Relation of Infant Mortality to Racial, Social, and Economic Factors.—It has been and it still is the custom among students of infant mortality to demonstrate statistically the correlation between rates of infant mortality and such factors as age of the mother, nativity of the mother, father's earnings, etc. There is no doubt that among older mothers infant mortality is unusually high, that among mothers attended by physicians the rate is often lower than among those attended by midwives or not attended at all; that infants which are breast fed during the first six months have lower mortalities than infants that are bottle fed; that the mortality is higher, the larger the number of people who sleep in the same room with the baby and the poorer the ventilation of the room; that infant mortality is higher the more illiterate the mother or the lower the father's earnings or the more severe the mother's employment immediately before and after parturition. The student of this subject can find splendid collections of statistical proofs for these correlations in such studies as those of the Children's Bureau. We need not present them here. It is well to remember, though, that because there is any definite parallelism between infant mortality and type of home, for example, it does not necessarily fol-

low that poor housing is a direct cause of infant deaths. While it is undoubtedly true that infants are better able to combat the invisible enemies which menace them when they are carefully housed, yet it is essential to recall that with bad housing there go hand in hand poor feeding, poor clothing, poor ventilation, lack of nursing and medical care, overcrowding, lack of maternal attention, and even specific sources of infection from sick people. Poverty, ignorance, sickness, and death go hand in hand. It is unsound to pick out any one evidence of either poverty or ignorance and give to it the blame for causing deaths of infants.

Viewed in another light, we may consider that there are two groups of factors at play, namely, those hereditary factors associated with race and family which make up what the biologist terms the hereditory factors of the protoplasm, and those which are concerned with the environment in which the infants are born. The two go together. Good hereditary race stocks generally succeed in making for themselve favorable environments; poor stocks either make or descend to unfavorable environments. The delicacy of the infant's health involves great dangers to life when coupled with unfavorable environment and poor physical heredity; it means lessened danger to life when combined with good heredity and good environment.

To the Health Officer, to the Director of a Nursing Association, to the field worker, and to the nurse these

considerations are of profound importance. To save infants' lives they must direct their efforts against those causes in the environment which are associated with high mortality, recognizing the while that the control of heredity lies outside of their domain. They must know that infant mortality rises in the warmer months of the year and that the principal causes of these excess deaths are intestinal. Hence they must concentrate their attention, in that season, upon the education of the mothers in careful feeding; they must take special pains to induce mothers to come to infant welfare stations for advice, care, and supervision. In the winter months they must know of the special dangers from respiratory infections and they must devote their efforts accordingly. The data adduced in this chapter have probably indicated in many ways how accurate statistical knowledge may serve as a valuable guide in the planning of infant welfare work and in measuring results.

Note.—The student who is interested in field work studies of infant mortality will find the publications in the Infant Mortality Series of the Children's Bureau, U. S. Department of Labor, Washington, D. C., particularly valuable and specifically instructive in the methods of conducting such studies.

For a careful study of the efficacy of infant welfare work the student is referred to the report by Dr. E. C. Meyer, "Infant Mortality in New York City," published by the Rockefeller Foundation, International Health Board, New York City, 1921.

CHAPTER V

MORBIDITY. SICKNESS IN THE COMMUNITY

It is scarcely necessary to point out at very great length the importance of sickness in a community. The suffering and the hardships which sickness entails upon the healthy as well as upon the sick is apparent to the observant individual, no matter what his profession, in almost any hour of the daily routine. Unusual are those individuals who do not know sickness in their own lives. Even rarer still is the family that suffers not from illness every year, every month, of its life. Sickness, like poverty, is literally always and everywhere with us. Some of it is avoidable and preventable; some of it is inevitable. The human organism is a fragile machine despite the fact that its normal functioning is partly safeguarded by physiological "factors of safety." Under the stress of environmental forces combined with internal weaknesses, hereditary or congenital, the occurrence of breakdowns is unavoidable. Sickness and suffering are the sequelæ.

Sickness—Preventable.—It is as grave an error to say that all sickness is in the last analysis preventable as to say that none is preventable. Some types of sickness—witness smallpox, typhoid fever, ophthalmia

neonatorum, trichinosis—are so largely preventable that we may say with little hesitation that they are *totally* preventable; other types—pneumonia, tuberculosis, organic diseases of the blood-vessels and heart, Bright's disease and nephritis, cancer, etc.—are not and may never be more than partly preventable. It is unfortunate, but none the less true, that we are not endowed with immortality. To be mortal makes it inevitable that we will be sick, and eventually, dead. Nevertheless, that there is a real case for sickness prevention needs no argument here. The humanitarian aspects of the problem demand that earnest attention shall be given to it and that officials of health organizations and public minded citizens shall devote their serious thoughts and efforts to it. Aside from any economic advantages, the humanitarian aspect alone places sickness prevention upon an important plane in the field of preventive medicine. Although prevention of sickness is an ultimate goal, thoughfully designed care of the sick is an immediate necessity.

With the problem of morbidity, as will be seen to be the case with that of mortality, before accurate preventive or curative steps can be taken it is essential to have at hand the facts with which to evaluate the seriousness of the problem, to know its extent and its chief characteristics. To prevent sickness we must have at hand accurate data on the extent of sickness in an ordinary population; in special types of population; the severity

of sickness; the available organizations to care for the sick; the causes; the forms of sickness; its incidence by sex, age, color, nationality, and race. We must know the influence of specific industrial and social conditions upon sickness. To carry on sickness prevention programs we must know the cost of sickness and must learn the cost of prevention. These are the starting-points in the campaign against sickness.

Meaning of "Sickness."—Here, as in so many other studies, before proceeding it is essential to define the meaning of salient terms. "Sickness" is readily spoken of, but is defined with greater difficulty and less alacrity. Almost any observer will agree that an individual who is in bed with pneumonia and fighting through the crisis is undoubtedly sick. Will they agree about the person who is at work despite a sniffling cold? For purposes of accurate analysis of morbidity statistics it is essential to define the meaning of the terms used. In one series of studies on the prevalence of sickness the term "sick" was used to include:

(*a*) Those persons who are up and about, but are unable to work because of sickness or accident.

(*b*) Those persons who are confined to bed at home because of disease or accident.

(*c*) Those persons who are receiving treatment in hospitals or other institutions for the sick.

It does not include those who are up and about and able to work, that is, those only mildy ill or those seri-

ously ill but able to work. An individual suffering from chronic pulmonary tuberculosis, yet able to be about and at work, is not, on this basis, a sick person. Obviously a broader interpretation of the term "sick" would give higher figures for sickness prevalence than those obtained by the use of the above classification. It is variations of this sort which make accurate comparisons of statistical data from different sources extremely difficult. Overlooking such differences in procedure is quite generally at the bottom of faulty work with statistics. The fault lies not with the statistics—they do not lie—but with the incautious persons who use them.

Sickness Severity.—For certain surveys of sickness severity and to meet other needs it has been found worth while to classify sicknesses in the following manner:

Sickness:
- (*a*) Non-disabling.
- (*b*) Disabling: 1. Partial { temporary. / permanent.
- 2. Total. { temporary. / permanent.

By use of this procedure it has been possible to make a reasonably accurate survey of the severity of sickness after the total survey has been made.

Morbidity statistics provide very valuable material for research on the method of spread of the infection, on the problems of personal, family, and race immunity,

on age and sex susceptibilities; they often suggest valuable means of preparation to combat the disease in the event of a recurrence; and sometimes give valuable hints as to the nature and habitat of the causative organism of the disease. (The student will find some very illuminating examples bearing this out in the history of malaria, yellow fever, typhoid fever, smallpox, beriberi, etc.)

In the study of morbidity (*i. e., sickness*) statistics a number of technical terms are used:

Morbidity, or Case Rate.—The *morbidity rate*, sometimes called the *sickness or the case rate*, is *the number of cases of a specific disease or group of diseases occurring during the year, taken generally per 100,000 persons in the average population for the year.* It is expressed, for example, as 125 (cases) per 100,000 (persons), and may be calculated from the following formula:

$$\text{Case rate} = \frac{\text{Cases of a disease}}{\text{Population}} \times 100{,}000$$

For special epidemiologic studies the cases and the population may be split up into special age, sex, race, occupation, or other groups. From the nature of the data from which it is calculated the accuracy of a morbidity rate depends upon the accuracy in the diagnosis of disease, upon the completeness of case reporting, and upon the accurate knowledge of the average or mid-year population. All of these possible errors must be

taken into consideration in statistical studies of morbidity. (For typical figures of morbidity rates the student should consult some monthly (or weekly) bulletin or the annual report of a progressive city or state Department of Health, the Public Health Reports of the United States Public Health Service, the Statistical Bulletin of the Metropolitan Life Insurance Company, the monthly or annual reports of Visiting Nurse Associations, etc.)

Fatality or Lethality Rate.—The *fatality* or *lethality rate* for a specific disease is *the number of deaths per 100 cases*. It is readily calculated in the following manner:

$$\text{Fatality rate} = \frac{\text{Deaths from a disease}}{\text{Cases of that disease}} \times 100$$

Fatality rates vary with age, sex, race, occupation, economic condition, geographic location, and other factors.

It was pointed out above that sickness reporting is not nearly as complete as death reporting. This fact influences the accuracy of fatality rates very appreciably because it means that the number of cases reported is too low compared to the number of deaths. Hence the fact that fatality rates are generally too high. It is commonly stated that the fatality in typhoid fever is 10 per cent.—*i. e.*, 10 deaths per 100 cases. Professor Whipple has pointed out that in a number of epidemics of typhoid where the case rate was accurately obtained by house-to-house canvass, the fatality rate was only

about 7 per cent.—*i. e.*, 7 deaths per 100 cases. In a recent water-borne epidemic of typhoid fever (Salem, Ohio) in which approximately 10 per cent. of the population was involved (morbidity rate of 10,000 cases per 100,000 persons), the fatality rate was as low as 2 (deaths per 100 cases). In a recent food-borne epidemic (Hopewell, Va.) the fatality rate was 6 (deaths per 100 cases). It is to be expected that for any disease the fatality rate may vary with the source and dosage of the infection; with the susceptibility of the population exposed to infection; with the virulence of the infecting organism; with the facilities available for the care and treatment of the sick; with the seasons of the year; and probably with other factors imperfectly understood.

If fatality rates were accurately known, or even knowable, it would be possible to use them to calculate the extent of sickness. For example, if the fatality rate for typhoid fever were actually 10, it would be possible to know the extent of typhoid morbidity by multiplying the reported typhoid mortality by 10 (*i. e.*, 10 cases of sickness for each death). This procedure has been employed in many studies. Its inaccuracies have been pointed out.

Sources of Sickness Statistics.—Statistical data on sickness have been obtained in a variety of ways, the most important and the ones to which recourse is most commonly had are the following (Kopf):

1. By the legal requirements of reporting
   (*a*) Communicable diseases.
   (*b*) Other reportable diseases, such as occupational diseases.
   (*c*) Accidents:
      Industrial.
      Traffic, etc.

2. Enumeration of sickness in a population by the census method.

3. Experience of special groups:
   (*a*) Hospitals:
      General hospital.
      Special hospitals and sanatoria.
      Tuberculosis, cancer, mental diseases, drug addiction, factory hospitals.
   (*b*) Dispensaries.
   (*c*) Convalescent homes.
   (*d*) Correctional and penal institutions.
   (*e*) Institutions for the aged and infirm.
   (*f*) Public health nursing experience.
   (*g*) Army and Navy medical, surgical, and sanitary service.
   (*h*) Health and accident insurance societies and companies.
   (*i*) Industrial groups under medical and insurance observation.
   (*j*) Private medical practice.

4. Experiences of health centers.

(The last was not included by Kopf, but has grown to be of considerable importance since his paper was published. The collection of data by health centers does not fall into any of the other groups.)

In previous chapters it has been pointed out that statistics of births are nearly (about 95 per cent.) complete in nearly two-thirds of the United States. It will be shown in a later chapter that the reporting of marriages and of deaths is in even a better state—more than four-fifths of the country showing adequate (complete or nearly complete) registration of deaths. The reporting of sickness is far from having reached such a commendable state. The registration of sickness is ultimately dependent upon the practising physicians of the country. They have not seen the importance of supplying administrative health officers with more accurate data on sickness prevalence. Only the outstanding communicable diseases, certain non-communicable morbid conditions (occupational diseases and accidents, principally), and venereal diseases have received attention from physicians. Nearly always this attention has been entirely inadequate. In point of fact it is not certain that health officers would be able to use more comprehensive data on morbidity unless these were supplied by physicians with scrupulous care and systematic accuracy. In this connection it is worth while to quote from Dr. John W. Trask, Assistant Surgeon-general of the United States Public Health Service.

He has very aptly described the attitude which physicians should take in the matter of reporting cases of sickness to departments of health:

"Unfortunately, many practising physicians have little knowledge of the methods of health administration and, in common with people in general, frequently expect the health department in some mysterious manner to control disease without placing upon them the burden and privilege of co-operating by the notification of the occurrence of cases. The practising physician, whether he recognizes it or not, or is so recognized by the community, is essentially an adjunct of the health department, for, unless he performs his part, the health department is in large measure helpless.

"Among practising physicians, at least in the United States, there has at times been the feeling that the knowledge of a disease in a patient is privileged information which they should not be called upon to impart. In communities where the laws require the notification of the disease this feeling has no legal basis, and the physician who does not make report is not a law-abiding citizen. But, aside from the legal aspects of the matter, there would seem to be little justification for such a course. Every physician has a number of individuals or families who look to him, and properly so, not only for treatment but also for such reasonable protection from disease as he is able to give. The failure to report the occurrence of a case of communicable disease in one patient may lead to its spread to others among his clientele whose rights he has ignored. He therefore violates the intent and spirit of the ethical principle of the protection of patients, among whom must be considered the well together with the sick. The notification of disease is in the interests and for the protection of the community, and as his patients are usually members of the community their

interests are ignored, and because of the antisocial whim or supposed convenience of the individual affected with a notifiable disease they are deprived of the protection they have a right to expect. It would seem that the physician who fails to report his cases of preventable diseases required to be notified may properly be considered as actively obstructing public health administration.

"The health department laboratory may be, and in many places is, an important factor in giving information of the occurrence of cases and prevalence of certain diseases. By having a diagnostic laboratory with a trained personnel at the service of the practising physician the health department becomes not only a consultant performing gratuitous service for the physician, but at the same time secures early and accurate information of many cases which otherwise might not be properly diagnosed and therefore not reported. A record of every positive diagnosis made by the laboratory should be sent to the epidemiologic bureau or other division of the health department responsible for the control of disease, and for purposes of morbidity records constitute notification of the case when accompanied by such necessary information as the name, age, sex, and address of patient. There would seem to be no good reason why the services of the health department should not be at the disposal of the community for the diagnosis of all diseases."

The Notifiable Diseases.—The legal requirements for the reporting of communicable and other diseases to the properly constituted health officials vary for different states in the country. This is due to the fact that legal matters of the sort lie within the jurisdiction of the states and are not under federal control so long as interstate affairs are not concerned. The problem of de-

veloping more or less uniform legal requirements in the different states is a very complex one and is far from a solution. Very definite attempts are being made, however, to evolve uniform procedures and thus to enhance the value of the statistical material collected. A so-called model state law for morbidity reports was adopted by the Eleventh Annual Conference of State and Territorial Health Authorities acting with representatives of the United States Public Health Service in Minneapolis, 1913, and it was recommended that its provisions—with such modifications as would be essential to meet local conditions—should be included in the laws of the states. Section 2 of this law recommends that the following-named diseases and disabilities shall be made notifiable, and the occurrence of cases shall be reported in the manner provided for:

GROUP I

Infectious Diseases

Actinomycosis.
Anthrax.
Chickenpox.
Cholera, Asiatic (also cholera nostras when Asiatic cholera is present or its importation threatened).
Continued fever, lasting seven days.
Dengue.
Diphtheria.
Dysentery:
(*a*) Amebic.
(*b*) Bacillary.
Favus.
German measles.

Glanders.
Hookworm disease.
Leprosy.
Malaria.
Measles.
Meningitis:
(*a*) Epidemic cerebrospinal.
(*b*) Tuberculous.
Mumps.
Ophthalmia neonatorum (conjunctivitis of newborn infants).
Paragonimiasis (endemic hemoptysis).
Paratyphoid fever.
Plague.
Pneumonia (acute).
Poliomyelitis (acute infectious).
Rabies.
Rocky Mountain spotted (or tick) fever.
Scarlet fever.
Septic sore throat.
Smallpox.
Tetanus.
Trachoma.
Trichinosis.
Tuberculosis (all forms, the organ or part affected in each case to be specified).
Typhoid fever.
Typhus fever.
Whooping-cough.
Yellow fever.

Group II

Occupational Diseases and Injuries

Arsenic poisoning.
Brass poisoning.
Carbon monoxid poisoning.
Lead poisoning.
Mercury poisoning.

Natural gas poisoning.
Phosphorus poisoning.
Wood alcohol poisoning.
Naphtha poisoning.
Bisulphid of carbon poisoning.
Dinitrobenzin poisoning.
Caisson disease (compressed air illness).
Any other disease or disability contracted as a result of the nature of the person's employment.

Group III

Venereal Diseases

Gonococcus infection.
Syphilis.

Group IV

Diseases of Unknown Origin

Pellagra.
Cancer.

The minimum information called for is given by the questions on the standard notification blank:

Standard Notification Blank

1. Date.
2. Name of disease or suspected disease.
3. Patient's name, age, sex, color, and address. (This is largely for purposes of identification and location.)
4. Patient's occupation. (This serves to show both the possible origin of the disease and the probability that others have been or may be exposed.)
5. School attended by or place of employment of patient. (Serves same purpose as the preceding.)
6. Number of persons in the household, number of adults and number of children. (To indicate the nature of the household and the probable danger of the spread of the disease.)

7. The physician's opinion of the probable source of infection or origin of the disease. (This gives important information and frequently reveals unreported cases. It is of particular value in occupational diseases.)

8. If the disease is smallpox, the type (whether mild or virulent strain), and the number of times the patient has been successfully vaccinated, and the approximate dates. (This gives the vaccination status and history.)

9. If the disease is typhoid fever, scarlet fever, diphtheria or septic sore throat, whether the patient had been or whether any member of the household is engaged in the production or handling of milk. (These diseases being frequently spread through milk, this information is important to indicate measures to prevent further spread.)

10. Address and signature of the physician making the report.

These reports are to be made on postal cards furnished for the purpose and mailed immediately to the local health department, so that proper measures can be taken to prevent the spread of the disease or to find the focus or source from which the case originated, that the occurrence of additional cases may be prevented. These reports are then to be forwarded to the State Department of Health, but before forwarding the local health department is to note thereon:

1. Whether the case was investigated by the local health department.

2. Whether the nature of the disease was verified.

3. What measures were taken by the local health department to prevent the spread of the disease or the occurrence of additional cases from the same origin.[1]

[1] In some departments of health the Standard Notification Blank is not used. The Registrars found that their use entailed a certain delay, one to three days, in the reporting of cases of disease. Instead they rely almost entirely upon reporting by telephone, taking down the reports upon forms which call for the essential facts about the disease and the patient, such as:

The Reporting of Sickness.—The existing conditions in the reporting of sickness and death are well illustrated by the figures presented in Table 24. They were obtained by averaging the statistics for 1920 of 83 cities of the United States, taking the average of reported *cases* and reported *deaths* for each disease in all the cities, and calculating the fatality rate—deaths per 100 cases.

TABLE 24

FATALITY RATES FOR CERTAIN DISEASES. REPORTED DEATHS PER 100 REPORTED CASES. 83 CITIES IN THE UNITED STATES, 1920

Disease.	Fatality rate.
Chickenpox	0
Diphtheria	3
Epidemic meningitis	20
Influenza	2
Measles	1
Mumps	0
Pneumonia, lobar	24
Poliomyelitis	8
Scarlet fever	1
Smallpox	0.03
Tuberculosis, pulmonary	25
Typhoid fever	5
Whooping-cough	1

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1. Name.
2. Age.
3. Residence.
4. Disease.
5. Duration.
6. Number of families.
7. Number of children.
8. School, shop, or factory.
9. Physician.
10. Date.
11. Remarks.

In such communities the telephone and personal visiting by the epidemiologist are utilized in securing additional information. Obviously such a method has its advantages as well as disadvantages, and while very valuable in some cities, particularly in small cities, it may or may not be feasible in large cities. A written report should preferably follow reporting by telephone. Without a written, complete report, competent epidemiologic work is often impossible.

These fatality rates are averages and represent the mean values of figures which range through considerable extremes. Thus, for example, in some cities there are fewer *cases* of tuberculosis reported than deaths from the same cause, and in others there are from 5 to 10 cases per death. In a similar manner, the reporting of other causes of sickness and of death vary markedly from city to city in their completeness. If for typhoid fever we accept, for the present, the commonly used 10 per cent. figure for fatality, it appears from the rate of 5 for this disease in the table, either that only *half* of the *deaths* from typhoid are being reported in these cities or that typhoid fatality was low in 1920. It is unlikely that more typhoid *cases* were reported than actually occurred. A more reasonable explanation of the low figure for typhoid fatality in 1920 is that the older figure (10 per cent.) was too high because of failure to report half of the *cases*.

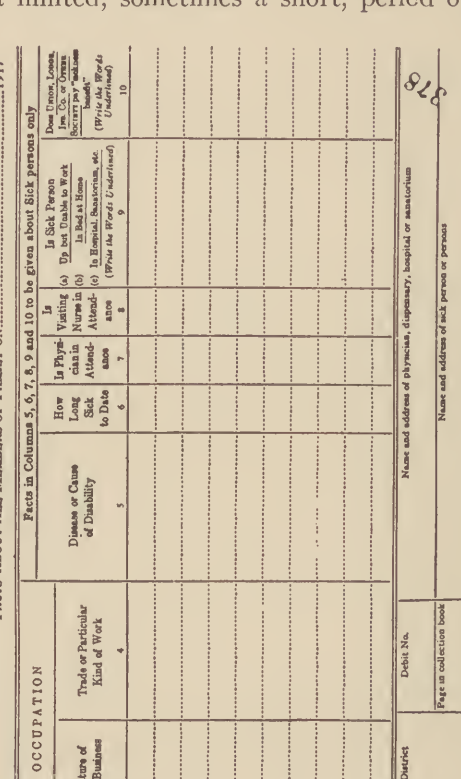
Causes of Sickness.—By international agreement the classification of causes of sickness, as well as of the causes of death, has been standardized to a degree commensurate with medical knowledge. Statisticians throughout the world use the "International List of Causes of Sickness and Death," and thus make it possible to compare morbidity and mortality data collected in different parts of the world. The basis of the classification is in part organological and in part etiological. The third decennial revision has only recently been

published following the convention of the International Commission in Paris, October 11–14, 1920, and can be found in the November, 1921 number of the *American Journal of Public Health* or in the *International Journal of Public Health* for January–February, 1921. Copies of this standard list of causes of sickness and death can be obtained by writing to the Census Bureau, Washington, D. C. Whenever possible, in statistical studies of disease or death by causes, the International classification should be adhered to.

Sickness Surveys.—In obtaining statistics on the prevalence of sickness by surveying the population it is obviously impossible to canvass the whole population when dealing with large communities. When a portion of the population is taken as a *sample* of the whole the greatest care is necessary in choosing a sample which is as large as can be studied and also which is truly representative of the whole population. If the sample chosen represents a portion of the population in better economic condition and living under better social conditions than the average of the whole community, the sickness rates found will obviously be too low for the whole population. And if the sample chosen represents a poorer portion of the community, the sickness rates will be equally inaccurate when applied to the whole population because they will be too high.

When it is necessary, because of the size of the population to be surveyed, or because of time limitation

upon the surveyors, that the survey shall be completed within a limited, sometimes a short, period of time, it



METROPOLITAN LIFE INSURANCE COMPANY—SICKNESS CENSUS

Form Stat. 30 Feb. 1917

FACTS ABOUT ALL MEMBERS OF FAMILY ON 1917

Male or Female	Age	Occupation: General Nature of Industry or Business	Occupation: Trade or Particular Kind of Work	Facts in Columns 5, 6, 7, 8, 9 and 10 to be given about Sick persons only: Disease or Cause of Disability	How Long Sick to Date	Is Physician in Attendance	Is Visiting Nurse in Attendance	Is Sick Person Up but Unable to Work / In Bed at Home / In Hospital, Sanatorium, etc. (Write the Words Underlined)	Does Union, Lodge, Ins. Co. or Owner Society pay sickness benefits (Write the Words Underlined)
1	2	3	4	5	6	7	8	9	10

White or Colored Family — No. of persons in family — No. of wage-earners in family — District — Page in collection book — Debit No. — Name and address of physician, dispensary, hospital or sanatorium — Name and address of sick person or persons

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Fig. 13.—Form used in obtaining data for a sickness census by the Metropolitan Life Insurance Company.

is exceedingly important that the most careful judgment should be used in choosing, if choice is possible, a period

of the year which is typical with respect to sickness of the whole year. In some studies this is obviously im-

INSTRUCTIONS TO AGENTS
Sickness Census, 1917

1. A slip should be handed in to the Superintendent for every family visited. Where there is no one sick, write the words "No One Sick" across Columns 5 to 10 of the schedule.
2. Every item called for should be filled out for each person in the family as per sample schedule.
3. The columns relating to sex, age, industry and occupation should be filled out for every person in the family whether sick or not.
4. The sick should include:
   (a) Those persons who are up and about, but are unable to work because of sickness or accident.
   (b) Those persons who are confined to bed at home because of disease or accident.
   (c) Those persons who are receiving treatment in hospitals or other institutions for the sick.
5. The question "How long sick to date" should be answered definitely in days, weeks or months.

Fig. 14.—Form used in obtaining data for a sickness census by the Metropolitan Life Insurance Company.

possible; in others it is highly feasible. The series of seven sickness surveys conducted by the Metropolitan

Life Insurance Company in the years 1915 to 1917 have given us some of the most complete data on community morbidity which we possess. The survey made in Rochester, N. Y., was conducted during a week of September; that of Trenton, N. J., in a week of October; the survey of Boston in two weeks of July; and the surveys of the State of North Carolina, the Chelsea neighborhood of New York City, certain cities in Pennsylvania and North Carolina, and of Kansas City, Mo., in periods of two or three weeks of March or April.

The Metropolitan Life Insurance Company's surveys included the families of industrial workers and covered, altogether, a total of some 580,000 white and some 58,000 colored persons of both sexes and all ages over one year. Of all the "sick persons," white and colored, 91 per cent. were "unable to work." This proportion ranged from 77 per cent. in Trenton to 96 per cent. in Pittsburgh and Kansas City. As indicated in Table 25 (page 113) there were 18.8 per 1000 persons sick (nearly 2 per cent. of the populations canvassed) and there was scarcely any difference between male and female sickness frequency.

The higher figures for the females between the ages of fifteen and forty-four years are directly attributable to the disability from child bearing and pregnancy. This fact is clearly borne out by an analysis of the causes of sickness. The cases caused by specific conditions associated with pregnancy and child bearing are sufficient

TABLE 25

CASES OF SICKNESS PER 1000 WHITE PERSONS BY SEX AND AGE PERIODS. METROPOLITAN LIFE INSURANCE COMPANY SURVEYS, 1915–1917. SICKNESS INVOLVING DISABILTIY TO WORK.

Age period.	Males.	Females.
All ages	18.7	18.8
–15 years	11.2	10.9
15–24 "	11.5	13.5
25–34 "	13.7	17.7
35–44 "	19.8	21.7
45–54 "	32.6	27.6
55–64 "	53.8	42.4
65+ "	105.9	86.7

in number to account for the difference in morbidity rate. It is evident from the figures that the sickness rate increases uniformly with age. This is true for both sexes. The Metropolitan's sickness surveys were made in districts scattered over a wide geographic area and covered markedly different climates and populations. From the fact that all the data collected show only comparatively small variations from the average it is probably safe to believe that they describe the prevalence of sickness in the general population accurately.

If we assume that on the average there are always 20 males of each 1000 who are sick, and if we allow three hundred working days per year per individual, we calculate:

$1000 \times 300 = 300{,}000$ working days per 1000 persons
and $20 \times 300 = 6000$ working days lost on account of sickness
6000 out of 300,000 = 6 in 300

A similar calculation for females gives nearly seven working days lost on account of sickness. That is on the average six to seven working days a year are lost to the community on account of sickness. Frequently the figures used range between five or five and a half and seven days per year. If we assume some arbitrary figure as the average daily wage of the worker in this country and multiply this by 7 and then by the number of males in the productive ages of life in the United States, we can get a figure which very conservatively approximates the cost of sickness in terms of lost wages only, a far too low figure for the total cost of sickness. Many years ago a very distinguished group—the Committee of One Hundred on National Health—very conservatively estimated the minimum loss of earnings because of sickness as over $5,000,000. For today the figure would be considerably larger.

The Framingham Sickness Survey.—The survey of sickness made in 1918 by the Community Health and Tuberculosis Demonstration at Framingham, Mass., is in many respects the most intensive and perhaps the most accurate of any of which we have record. The canvass was made on a relatively small group by carefully instructed workers and only after careful preparation of the public by a successfully organized campaign of publicity. The survey was followed by a community medical examination campaign, and the results obtained by the two methods carefully compared.

Corresponding with the greater intensity of the survey and with a more liberal interpretation of what constituted disability a great many more cases of sickness were found than have been recorded in any previous sickness survey. These additional cases were very largely cases of minor illness. The most common affections were:

	Per cent.
Colds	13.5
Heart disease	8.6
Rheumatism	6.6
Diseases of the stomach	5.9
Tuberculosis	3.9
"Coughs"	3.9
Bronchitis	3.9
Influenza	2.7
"Nervousness"	2.7
Diseases of the kidneys	2.7

In the group surveyed, about 6500 persons, 407 sick persons were found, a sickness rate of 6.2 per cent., or *62* per 1000 persons. This compares with figures of *28* for North Carolina, *19* for Boston, and *21* for Rochester found by the Metropolitan surveys. When the term "illness" is restricted to mean what it meant in the Metropolitan surveys, the figure of *62* is reduced to *18* per 1000. The relation between illness and economic condition found in Framingham is given in the following table:

Economic condition.	Morbidity rate (cases per 1000 persons).
Good	52
Fair, poor, and bad	74
Unknown	52

Extent of Tuberculosis Morbidity.—With respect to tuberculosis, the Framingham survey brought out that nearly *1 per cent.* of the persons examined were suffering from active tuberculosis, while somewhat over 1 per cent. more were arrested cases. The findings indicated a ratio of 9 or 10 active cases during the year to 1 reported death. In most communities there are usually from less than 1 to $1\frac{1}{2}$ or 2 *cases* of tuberculosis reported for each reported *death* from the same disease. This comparison indicates how inaccurate the data on certain "reportable diseases" is when taken directly from the records of Health Departments. Of course, it is scarcely true that the reporting of many other "reportable diseases" is as sorely neglected as is that for tuberculosis.

Hospital Statistics.—The statistics of morbidity which are reported by hospitals can be found in their annual reports. Data taken from these sources are nearly always useless for the purpose of describing either the extent or severity of sickness in the general community. On the whole, hospital sickness experience is too severe and too protracted when compared with general sickness experience. And, obviously, the sickness of a specializing hospital will be even less typical for the community in which it is located than that of an institution doing general or mixed service.

Sickness Statistics from Nursing Associations.—The statistics of sickness that can be drawn from the ex-

perience of public health nursing associations must be taken with caution and with understanding of their limitations. Thus in a city of approximately 170,000 population there were in 1921 11,000 patients cared for by a visiting nurse association doing general and special nursing. If these figures are to be taken in the same sense in which sickness figures are taken in such studies as the Metropolitan Life Insurance Company's surveys, it would mean that this city had a sickness rate for the year of 6.5 per cent. (compared to the 2 per cent. figure of the Metropolitan Life Insurance Company *for the number sick at any one time*), assuming that the association was caring for all the sick in the community. Without a doubt they are not caring for but a part of all the sick. It is obvious the term "sick" is insufficiently restricted when applied to all the patients listed by a visiting nurse association. Contacts and members of families are included. Thus, this same nursing association listed 1100 patients in its tuberculosis department in a year in which there were 140 deaths from this disease reported to the city department of health. If these figures could be taken at their face value, it would mean that the association had under its nursing care 8 tuberculous persons for each reported death from tuberculosis. The findings of the Framingham Demonstration (discussed above) indicate that there are probably 10 active cases for each death from tuberculosis. It is exceedingly improbable that this nursing association

either had record of or was caring for anything like eight-tenths of all actively tuberculous persons in the city. Obviously, not all persons cared for by a tuberculosis division of a nursing association are actually or actively tuberculous. A large proportion is made up of contact cases. Analysis of other data from this source of vital statistics would reveal how carefully the figures and terms must be refined and defined.

The age distribution of patients or the proportions of one or another type of disease treated by a public health nursing association do not necessarily indicate the statistical relations for an average, mixed population, unless the association is taking on all sick persons of any age suffering from any cause. There probably is no such association in existence and, correspondingly, there are no nursing association statistics on general community sickness. It is perhaps of interest to find that when we combine the data from the annual reports of nine different visiting nurse associations for an average of two years each, regardless of types of services rendered, number of nursing visits per patient, cause of sickness or any other factor, there were about 193,000 patients in a population of about 13,200,000 persons. That is, these nursing associations were carrying on the records for each year, on the average, $1\frac{1}{2}$ (1.5) per cent. of the populations of the cities in which they were located. Nursing association statistics are not now, but they should become, available for careful and valuable

analysis. It is the duty of individual nurses as well as of office clerks, secretaries, and superintendents to contribute to improved record keeping and more valuable statistical analysis.

Sickness Statistics from Special Groups.—A very important statistical study of disability in a special population group (wage-earners) was made by Dr. Boris Emmet, reporting in the Monthly Labor Review for November 1919 upon the experience of the Workmen's Sick and Death Benefit Fund of the United States of America. During the period covered by this study (1912–1916) there were 40,000 to 44,000 members in the Society distributed over some forty groups of occupations. The proportion of males to females in this group is not stated. The average age is given as 42.9 years, indicating a population older, on the average, than the male (white) wage-earning population of the country at large. No distinction is made between ordinary sickness and non-industrial and industrial accidents, all being lumped together under the term "disability." The average disability (for the five years' statistics) was 28.1 days per disabled person and 6.6 days per member. This latter figure checks very closely with the figure given above for time lost on account of sickness in the general populations surveyed by the Metropolitan Life Insurance Company. Table 26 (see page 120) shows how the number of days lost per member

and the number of disability days per disabled person increase with the ages of the members.

TABLE 26

DAYS LOST THROUGH DISABLEMENT PER MEMBER AND PER DISABLED PERSON FOR EACH FIVE-YEAR AGE GROUP. WORKMEN'S SICK AND DEATH BENEFIT FUND OF THE U. S. A., 1912–1916

Age group.	Average number disability days per member.	Average number disability days per disabled person.
Under 20 years	5.2	16.6
20–24 years	4.8	19.3
25–29 "	5.0	21.4
30–34 "	4.9	21.8
35–39 "	5.6	25.0
40–44 "	6.4	27.6
45–49 "	6.6	28.9
50–54 "	7.4	31.4
55–59 "	9.0	35.2
60–64 "	12.0	43.3
65–69 "	13.8	45.5
70+ "	15.2	52.6
All ages	6.6	28.1

The influence of occupation upon days lost from sickness and accidents is indicated by Dr. Emmet's paper. The figures from which his charts were prepared were corrected by a statistical method for differences in the ages of persons in each occupation, so that the final figures for different occupations are comparable. (See Fig. 15, page 121.) Miners are at the head of the list, with an annual average loss of 9.7 days per person, and professional people at the foot of the list, with 2.6 days per person, as compared with 6.4 for all occupations.

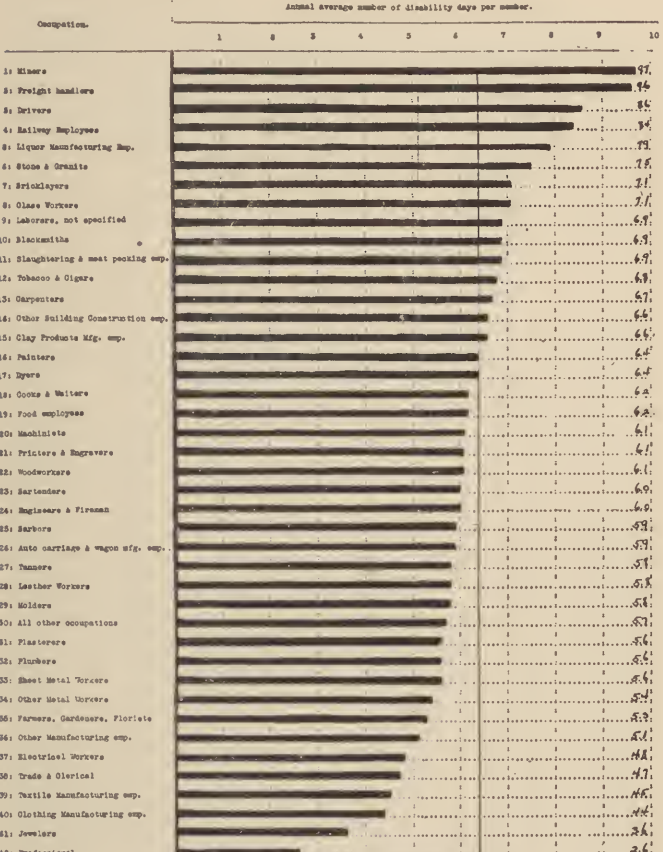


Fig. 15.—Corrected number of disability days in a year, per member, for each occupation in a group whose ages ranged from twenty-five to fifty-nine years (Emmet).[1]

The influence of season upon sickness frequency is clearly illustrated in Table 27, taken from a report is-

[1] We are indebted to the Bureau of Labor Statistics of the United States Department of Labor for the use of this figure.

TABLE 27

INFLUENCE OF SEASON UPON SICKNESS FREQUENCY, JANUARY–JUNE, 1920

Month of onset.	Cases of sickness per 1000 persons per year.[1]
January	267
February	324
March	133
April	111
May	94
June	82

sued by the United States Public Health Service (Public Health Reports, December 3, 1920) concerning the frequency of disabling sickness among members of sick benefit associations in certain industrial establishments. Inasmuch as only those cases of sickness which caused industrial disability for at least one week were included in this study, that is, only the more severe illnesses were included, the figures are not entirely comparable with those obtained in other studies in which less severe illnesses were included.

The peak of sickness was reached in February, with a rapid decline in March. Such figures as these argue that visiting nurse associations and other organizations concerned with the care of the sick must be prepared for a special siege of sickness frequency in the winter months through February and, sometimes, March. (Lack of information in connection with the figures from which Table 27 is taken makes it impossible to

[1] Sickness of at least one week's duration.

tell whether the seasonal variations of sickness frequency are very closely or only distantly related to geographic location of the population.)

Very recently Dr. Brundage, of the United States Public Health Service, has reported the findings of a sickness survey on a special population group—office workers. Here, instead of determining the amount of sickness occurring in the group during a short period of time, records were kept of all time lost from work during a year. The average number of persons on the company's pay roll was 1282, with women in the majority. Illnesses causing disability were diagnosed by the industrial medical department or by the family physician. In a general working population there are more males than females, but in the special group studied here there were more females than males. This sex variation would tend somewhat to make the sickness rate abnormally high. The occurrence of an influenza epidemic during the period of this study tended to increase the rate still further. On the other hand, the fact that these office employees were, on the whole, comparatively young persons, were doing only light clerical and executive work, and were under competent, organized medical supervision would tend to diminish the morbidity rate.

The statistics collected in this study show that there were approximately 2 cases of disabling sickness per person per year. The average number of working days lost per case was 3.8. This gives us a figure of 7.6 working

days per person lost during a year, a figure which agrees very closely with that given above from the survey

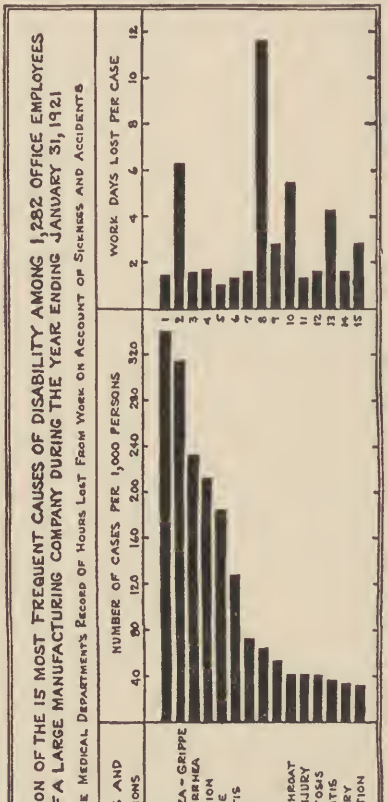


Fig. 16.

data. The duration of each of the fifteen most frequent causes of disability in the group is illustrated in

Fig. 16 which is taken from the original paper by Brundage.[1]

The Costs of Sickness.—The committee of eighteen engineers whose appointment by Herbert Hoover was authorized by the American Engineering Council, the executive body of the Federated Engineering Societies, reported recently on industrial waste in six important industries—the building trades, men's ready-made clothing, boot and shoe industry, printing, metal trades, and textile manufacturing. In the preliminary report the committee declares that sickness is the chief cause of loss of production. "The 42,000,000 men and women gainfully employed probably lose on an average more than eight days each annually from illness disabilities, a total of 350,000,000 days. . . . It has been estimated that the (annual) economic loss from preventable disease and death is $1,800,000,000 among those classed as gainfully employed. . . . There is experiential basis for the statement that this loss could be materially reduced and leave an economic balance in the working population alone over and above the cost of prevention of at least $1,000,000,000 a year."

It is interesting to study the method of obtaining an estimate of the cost of sickness and disability. The following illustration—calculation of the annual loss

[1] Public Health Reports, March 10, 1922. Prepared by National Research Council, Washington, D. C. Reproduced with the permission of the Surgeon-general of the United States Public Health Service.

ANNUAL LOSS—PREVENTABLE DISABILITY (SICKNESS AND ACCIDENT)

Average for Years 1915–1919

Loss in income to individuals:	
One-fourth population are wage-earners = 350,000 Average days lost yearly from preventable causes = 4 Average wage = $2.50	
350,000 × 4 × $2.50 =	$3,500,000
Loss to industry:	
It is accepted that the loss to industry in disorganization, idle overhead, and lessened production is $2\frac{1}{2}$ times the wage loss.	
3,500,000 × $2\frac{1}{2}$ =	8,750,000
Medical attendants:	
Two thousand physicians and surgeons with an average income of $3000 devote one-half of their time to treating preventable disability.	
2000 × $3000 × $\frac{1}{2}$ =	3,000,000
Nursing service:	
Three thousand nurses with an average income of $1000 are half employed on cases of preventable disability.	
3000 × $1000 × $\frac{1}{2}$ =	1,500,000
Drugs and accessories:	
1,400,000 people spend at least $3.00 per capita for drugs, etc., one-third for relief of preventable conditions.	
1,400,000 × $3.00 × $\frac{1}{3}$ =	1,400,000
State institutions (1919 statistics):	
Tuberculosis sanatoria = $604,000 Humane institutions—one-half for care of those afflicted with or suffering as a result of preventable illness.	
2,700,000 × $\frac{1}{2}$ + $604,000 =	1,954,000
Total annual loss preventable disability	$20,104,000

Total

Preventable deaths	$20,975,600
Preventable disability	20,104,000
Total annual loss (1915–1919)	$41,079,600

from *preventable* disability—is taken from a report of the State Department of Health of Connecticut.[1]

A total annual loss in Connecticut from preventable accidents and sickness of $20,000,000 is probably no overstatement of the facts.

The book-keeping of health centers is a comparatively new source of data. But it seems quite certain that in a few years health centers will be striving to collect accurate, complete community vital statistics and to give the most accurate observations of the pulse of health in their communities.

[1] State of Connecticut, Public Document No. 25. Thirty-seventh Report of the State Department of Health for the Two Years Ending June 30, 1922, p. 31.

CHAPTER VI

MORBIDITY (*Continued*). THE INCIDENCE OF PHYSICAL DEFECTS

No discussion of morbidity would be complete without a description of the statistical evidence for the frequency of physical defects in a population. For the purpose of the brief analysis which can be made here we may consider the data under three headings: Physical defects among (1) preschool children; (2) school children; (3) adults.

Physical Defects Among Preschool Children.—In 1918–19, in the course of the weighing and measuring test of "Children's Year" conducted under the auspices of the Children's Bureau of the United States Department of Labor, a great mass of information was collected upon the statures and weights of children and upon the occurrence of physical defects. The data in Tables 28 and 29 are taken from the examination by physicians of approximately 58,000 children in California and in New York City.[1]

In addition to those defects listed in Table 28, less than 0.1 per cent. of the children showed the following conditions: deaf, enlarged thyroid, blind (one or both eyes), spina bifida, and Pott's disease; and approxi-

[1] Compiled from Statures and Weights of Children under Six Years of Age, by Robert Morse Woodbury, Bureau Publication No. 87, Children's Bureau, United States Department of Labor, 1921.

TABLE 28

OCCURRENCE OF CERTAIN PHYSICAL DEFECTS AMONG WHITE CHILDREN UNDER SEVEN YEARS OF AGE. CALIFORNIA AND NEW YORK CITY

Defect.	Per cent. of children showing specified defect.
Tonsils enlarged or diseased	17.7
Tonsils removed	0.2
Adenoids present	6.4
Adenoids removed	0.1
Carious teeth	3.6
Enlarged neck glands	2.1
Rupture	1.4
Rachitis	1.2
Malnutrition	1.0
Heart abnormality	0.8
Bow-legs, knock-knees, or both	0.6
Strabismus	0.5
Crippled	0.1
Infantile paralysis	0.1
Discharging ears	0.1
Total	35.9

mately 0.1 per cent. of the children were mentally deficient. The distribution of certain of these defects according to age is indicated in Table 29.

TABLE 29

OCCURRENCE OF CERTAIN PHYSICAL DEFECTS AMONG WHITE CHILDREN ACCORDING TO AGE. CALIFORNIA AND NEW YORK CITY

	Percentage of children showing					
Age.	Diseased or enlarged tonsils.	Adenoids.	Carious teeth.	Rachitis.	Malnutrition.	Heart abnormality.
All ages under seven	17.7	6.4	3.6	1.2	1.0	0.8
Under 1 year	3.7	1.7	[1]	0.8	1.7	0.2
1–2 years	15.5	5.8	0.4	1.9	0.9	0.4
2–3 "	25.7	8.9	2.1	1.5	0.5	0.5
3–4 "	27.3	9.5	5.6	1.1	0.6	1.1
4–5 "	26.5	9.2	9.4	1.0	0.6	1.5
5–6 "	29.7	11.0	12.7	0.7	0.8	2.2
6–7 "	27.8	11.6	14.7	1.1	1.2	3.3

[1] Less than 0.1 per cent.

Of course, the accuracy of these figures varies according to the standards of the different examining physicians and according to the difficulties of diagnosis in the different conditions. It is important to note that nearly 36 per cent. of these preschool children showed physical defects of one kind or other. Diseased or enlarged tonsils—the most frequently reported defect—are more common among children three to seven than up to three years of age. Similarly, adenoids, carious teeth, and heart abnormalities increase in frequency with age. The prevalence of rachitis and malnutrition is approximately the same in each of the seven years of life.

In the more recent report on the physical status of the preschool children of Gary, Indiana, by Dr. Anna E. Rude, the percentage of children two to seven years of age showing physical defects was very much higher (see Table 30).

These figures are based upon the examinations of 3125 children (1555 boys and 1570 girls). The examinations were very carefully made and the definition of each type of defect stated as explicitly as possible. It is, therefore, not surprising that the results showed defects of one kind or another in the body of nearly every child (96.9 per cent. of the boys and 93.6 per cent. of the girls). Except for the higher figure for boys for defects of the genitalia (almost entirely prepucial defects) the figures for the two sexes show no

TABLE 30

PREVALENCE OF PHYSICAL DEFECTS AMONG MALE AND FEMALE CHILDREN, TWO TO SEVEN YEARS OF AGE. GARY, INDIANA

Defect.	Percentage of children showing specified defect: Both sexes.	Males.	Females.
None	4.8	3.1	6.4
All defects	95.2	96.9	93.6
Underweight	9.7	9.0	10.4
Anemia	7.8	7.3	8.3
Defect: Head	5.2	6.8	3.7
Eyes	28.5	28.1	28.9
Ears	9.4	11.0	7.9
Mouth	66.9	67.1	66.8
Nasopharynx	69.0	71.9	66.2
Glands (enlarged)	29.1	31.4	26.7
Heart	3.2	3.1	3.2
Lungs	1.0	1.4	0.7
Skin	10.2	8.8	11.5
Abdomen	14.8	15.0	14.6
Bony and muscular system	41.9	45.6	38.2
Nervous system	2.4	2.7	2.1
Genitalia	....	47.1	2.4

important differences. (For the detailed data from which Table 30 has been compiled the student should consult the original report.[1])

From these astoundingly high frequencies of defects among young children the importance of a program for the early care of the child by physicians is very clear.

Physical Defects Among School Children.—"A study of the extent of physical defects among school children shows that almost universally approximately 35 per cent. of the children of school age have one or more

[1] Physical Status of Preschool Children, Gary, Indiana, by Anna E. Rude, M. D., Bureau Publication No. 111, Children's Bureau, United States Department of Labor, 1922.

physical abnormalities, such as malnutrition, defects of hearing, lung disease, hypertrophied tonsils, adenoid growths, or defective vision. In this 35 per cent. are included those who may have defective teeth associated with one or more of the other defects that have been mentioned. As far as defective teeth alone are concerned, statistics are available to show that from 30 to 65 per cent. of the children who are otherwise normal have teeth that are in some degree defective. From our personal knowledge we may assume that every child between the ages of five and fifteen years needs dental care" (S. Josephine Baker.[1])

The data in Table 31 were taken from the report by Dr. Baker upon the incidence of defects among boys and girls in the schools of New York City in 1909 and in 1921. In 1909, 356,292 children had been examined and in 1921 a similar study was made upon 139,770 children. The student should study Table 31 carefully and examine the original paper for a detailed discussion of the findings.

The incidence of physical defects among children of school age is very high (about 100 defects per 100 children at all age periods in the group). The findings may be summarized in Dr. Baker's own words:

"1. The less common and more chronic defects, such as pulmonary disease, cardiac disease, and nervous disease, remain at about the same level throughout school life, and are apparently influenced little, if at all, by the school environment.

[1] School Health Supervision Based upon Age and Sex Incidence of Physical Defects, by S. Josephine Baker, in the American Journal of Public Health, 1922, vol. 12, pp. 465–476.

TABLE 31

Defects Found in New York City School Children: 1909 and 1921

Age.	Year.	Number examined:		Percentage showing																		Average number of defects per 100 children:	
				Defective vision:		Defective hearing:		Hypertrophied tonsils:		Defective nasal breathing:		Defective nutrition:		Pulmonary disease:		Cardiac disease:		Nervous disease:		Defective teeth:			
		Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
Under 8	1909	96,179	89,528	...	...	0.5	0.4	30.0	29.0	27.0	23.0	3.6	3.9	0.8	0.6	0.5	0.6	0.3	0.2	62.0	61.0	124	118
	1921	37,916	35,309	...	...	0.1	0.09	17.1	16.9	16.1	14.2	17.0	16.7	0.1	0.08	0.6	0.5	0.4	0.4	60.3	57.7	113	107
8–10 years	1909	44,052	41,551	12.0	14.0	1.0	0.8	25.0	27.0	25.0	22.0	4.1	4.2	0.6	0.4	0.6	0.7	0.4	0.3	67.0	63.0	133	132
	1921	14,631	14,899	9.1	11.0	0.7	0.6	13.6	13.5	11.3	11.3	19.2	19.2	0.2	0.1	0.8	0.8	0.6	0.5	59.5	60.3	115	117
10–12 years	1909	23,100	22,869	17.0	21.0	1.6	1.3	24.0	27.0	23.0	26.0	2.8	3.6	0.4	0.3	0.6	0.7	0.4	0.3	53.0	51.0	122	131
	1921	9,114	8,710	11.5	13.7	0.8	0.7	12.5	12.7	11.7	10.2	20.5	21.0	0.2	0.2	1.0	1.2	0.7	0.5	53.9	52.7	113	113
12–14 years	1909	14,553	14,470	19.0	24.0	2.3	1.6	25.0	27.0	21.0	27.0	2.7	2.5	0.3	0.3	0.8	1.0	0.6	0.4	47.0	44.0	119	105
	1921	6,917	6,625	12.2	13.7	1.1	1.9	11.9	12.0	9.5	8.4	17.9	17.4	0.3	0.2	1.2	1.6	0.7	0.8	44.4	42.9	99	99
14 years and over	1909	5,180	4,810	21.0	22.0	2.8	2.7	21.0	22.0	18.0	21.0	2.4	2.2	0.5	0.2	1.0	1.0	0.8	0.5	42.0	43.0	108	113
	1921	2,950	2,699	13.3	17.2	1.8	1.3	11.0	10.5	8.4	6.4	14.7	15.1	0.2	0.07	1.2	1.6	0.6	1.0	43.9	35.0	95	88

"2. Defective hearing and defective vision show a steady and persistent increase from the entering age to the leaving age through the school life of the child. In the case of defective hearing, however, the increase is relatively small; in the case of defective vision the increase is more marked.

"3. Malnutrition, defective nasal breathing (implying the presence of adenoids), hypertrophied tonsils or diseased tonsils, and defective teeth show their highest incidence either at the entering age or at the eight- to ten-year period, thereafter showing a fairly persistent and regular decline.

"4. While the incidence of physical defects in all age groups is lower in the 1921 study than in the 1909 study, the relative age incidence remains approximately the same, the percentage of defects found at each age bearing about the same relative position in both studies.

"5. The physical examinations and follow-up work for school children in the years intervening between 1909 and 1921 have evidently reduced the total number of physical defects, with a resultant raising of the health standards of the children examined. They have not, however, resulted in a change in the relative age ratio of the physical defects encountered."

The general tendency for decline in the frequency of defects in the period 1909–1921 is indicated in Table 31 in spite of the fact that the examinations were probably conducted more carefully and were better designed to discover defects in 1921 than in 1909. The very marked *increase* in defective nutrition disclosed by the more recent examinations of New York City school children is probably an anomaly attributable to the important advances which have been made in the ac-

curacy of detecting malnutrition. It is exceedingly unlikely that the prevalence of defective nutrition—using the definition of the 1921 study—was anything as low as indicated by the 1909 data.

The very valuable data upon the incidence of defects among children in the schools of Boston prepared by Dr. Devine[1] indicate that in the years 1907 to 1921 defects of vision and of hearing have been declining regularly. In the period 1916–1921 inclusive *defective nasal breathing*, *hypertrophied tonsils*, *cervical glands*, and *skin diseases* showed marked reductions in frequency of occurrence; *defective teeth* consistently showed moderate reductions; *non-tuberculous orthopedic defects* showed no important changes, and cardiac disease and malnutrition showed significant increases in frequency.

A recent report from Dr. G. T. Palmer[2] shows that 7.87 per cent. of the elementary school children of Detroit were 15 per cent. or more underweight. Table 32 was prepared from illustrative data in his report, and shows the occurrence of physical defects among those first and fifth grade children who were of normal weight for height and 15 per cent. or more underweight for height (Emerson Tables of Weight-height).

[1] Report of the Director of Medical Inspection in the Annual Report (October, 1921) of the Superintendent of Boston Public Schools, School Document No. 11, 1921, Appendix E.

[2] A year's experience with nutrition classes in Detroit, in City Health (the monthly bulletin) of the Detroit Department of Health for November, 1922.

TABLE 32

PHYSICAL DEFECTS AMONG SCHOOL CHILDREN, DETROIT, MICHIGAN, 1921

Defect.	Percentage of children with defects. First grade: Underweight.	First grade: Others.	Fifth grade: Underweight.	Fifth grade: Others.
Tonsils—enlarged or infected	61.0	59.3	50.2	48.7
Defective teeth	30.0	24.3	19.7	27.8
Mouth breathing	11.8	11.8	8.8	4.3
Anemia	8.6	4.0	7.4	3.0
Faulty vision	5.3	6.1	11.9	12.0
Heart—abnormal	4.0	2.7	4.2	1.9
Lungs—suspicious	3.2	3.3	3.1	1.9
Cervical glands—enlarged	2.1	0.6	1.8	0.45
Defective hearing	1.7	1.8	2.9	1.9
Skin eruptions	1.5	1.8	1.5	0.89
Thyroid enlarged	0.9	1.5	4.0	5.3
Orthopedic defects	0.5	0.9	1.3	3.7
Deformed palate	0.0	0.05	0.0	0.13

Among nearly 9000 "underweight" children of all grades, physical examinations disclosed that 75 per cent. showed defects. For school children of the entire city the "underweight" group showed more than twice as many markedly anemic children, twice as many heart cases, and three times as many with enlarged cervical glands.

Physical Defects Among Adults.—Many studies of the incidence of physical defects among special population groups—*i. e.*, employees in a particular occupation—are available in the literature, but very few—so far as we are aware—upon large samples of the general adult population. Therefore, for the purposes of this brief discussion, a few sets of data have been chosen which

probably approximate certain general population conditions, but whose utility for broad generalizations is far from certain.

In 1917, when the first selective draft was in operation for recruiting the armies of the United States, out of approximately 10,000,000 males of the ages twenty-one to thirty years who had registered for the draft, some 2,500,000 men were measured and examined by the physicians of the local boards. Of these, 730,000, or 29.1 per cent., were rejected on physical grounds as unfit for general military service. Between December 15, 1917 and September 11, 1918 about 3,200,000 men were examined by the local boards. By May, 1918 approximately 1,000,000 men from these two groups had been sent to mobilization camps; they were re-examined and the physical defects in them recorded. The data in Table 33 (page 138) show the outstanding findings.[1]

An impressive list indeed! We cannot enter here into a discussion of the qualifications with which these figures must be treated—the problems of medical standards, accuracy of diagnosis, severity of the defects, etc. We must merely indicate that these findings are for a group of men in the prime of life, and that the obviously defective and unfit individuals had already been weeded out before this million was sent to the mobilization

[1] Taken from the report on Physical Examination of the First Million Draft Recruits: Methods and Results, Compiled under direction of Surgeon-general M. W. Ireland, by Albert G. Love and Charles B. Davenport, Washington, 1919, 521 pp.

TABLE 33

FREQUENCY OF VARIOUS DISEASES AND DEFECTS FOUND AT MOBILIZATION CAMPS IN FIRST MILLION MEN, UNITED STATES, 1917–1918

Diseases and defects.	No. per 1000 recruits.
Flat foot	177.45
Venereal diseases (all)	28.99
Throat diseases	24.28
Gonorrhea	23.44
Enlarged inguinal rings	20.28
Hernia	13.79
Defective vision	7.86
Diseases of heart valves	7.19
Congenital defects of feet	7.03
Defective or lost teeth	4.96
Pulmonary tuberculosis	4.94
Syphilis	4.49
Varicocele	3.34
Otitis media. Underweight. Ankylosis	2.60
Mental deficiency	2.45
Fractures, malunions	2.02
Simple goiter	1.85
Congenital defects of testes	1.81
Skin diseases	1.58
Varicose veins	1.44
Refractive errors of eyes	1.42
Chancroid	1.06
Hemorrhoids	1.03
Defects of physical development	.80
Scoliosis	.75
Asthma	.63
Functional heart disease	.61
Arthritis. Psychoses	.60
Defective hearing	.58
Hypertrophy and dilatation of heart	.53
Diseases of nose	.53
Trachoma	.47
Functional nervous disorders	.46
Exophthalmic goiter	.45
Constitutional psychopaths	.31
Drug addicts	.29
Myocarditis	.18

camps. Yet nearly 20 per cent. of the men showed flat-feet; approximately 3 per cent. had venereal disease of one kind or other; 2.5 per cent. were suffering with diseases of the throat; 2.3 per cent. had gonorrhea; 2.0 per cent. showed enlarged inguinal rings; nearly 1 per cent. showed evidences of diseased heart valves, defective vision, etc. There is no need of running through the gamut of afflictions which, it was found, beset "healthy" men. How much higher the incidence of defects is in older men we can only approximate from other data.

In Table 34 we have arranged some data which were published in greater detail in the Statistical Bulletin of

TABLE 34

PHYSICAL IMPAIRMENTS AMONG WHITE MALES. EXPERIENCE OF THE METROPOLITAN LIFE INSURANCE COMPANY, 1921

Impairment.	Percentage of persons in specified age group showing the impairment:					
	All ages.	Under 25.	25 to 34.	35 to 44.	45 to 54.	55 and over.
Underweight and overweight.	15.3	6.9	11.3	16 7	20.4	21.9
Eye and ear defects	56.1	45.5	48.6	52.8	68.9	81.0
Nose and throat defects	77.5	91.5	88.5	77.7	60.1	54.3
Teeth and root infections	65.4	41.2	58.6	69.1	74.5	75.6
Heart and pulse defects	19.9	21.6	18.2	18.2	22.3	30.0
Abnormalities in blood-vessels and blood-pressure	100+[1]	100+[1]	100+[1]	100+[1]	100+[1]	100+[1]
Stomach and abdominal organ defects	54.9	40.8	51.7	56.5	60.8	58.9
Defects of the inguinal region.	19.1	17.3	17.2	18.6	21.9	25.1
Defects of genito-urinary organs	3.9	1.0	2.0	3.1	5.6	15.8
Endocrine disturbances	2.1	3.1	3.3	1.6	1.1	0.8

[1] This means that, on the average, each individual in the group showed more than one impairment of this type.

the Metropolitan Life Insurance Company for October, 1922. The descriptive text concerning these figures are quoted at length because they constitute the source of some of the most accurate information which is available in this field of statistical inquiry. That the incidence of physical impairment in white males is even higher in this group than in the army draft group is not surprising when it is observed that the physical examinations (conducted by the Life Extension Institute) were very carefully conducted, utilizing x-ray and laboratory facilities. Of the 16,662 policyholders in the group, 861 were under twenty-five years of age, 5885 were twenty-five to thirty-four, 5799 were thirty-four to forty-four, 3023 were forty-five to fifty-four, and 1094 were fifty-five years of age and over. (This group of males were policyholders in the Ordinary Department.)

"Overweight is one of the most common of the impairments found. Virtually 13 per cent. of all the persons examined had a weight one-fifth or more in excess of the average for their height and age. This condition increases perceptibly with advancing age. Among these overweights 55 per cent. required systematic medical or surgical attention according to the medical examiners, whereas, persons of normal weight showed only 18 per cent. who required such immediate attention. Exactly 1 per cent. of the group showed organic heart murmurs and 6 per cent. more had functional murmurs or irregularities. More than $2\frac{1}{2}$ per cent. showed enlargement of the heart. Arterial thickening, moderate or marked, was present in over 5 per cent. of the

cases and at the ages over fifty-five this proportion rose to 17 per cent.

"Respiratory findings were rather slight in proportion. Suspected and incipient tuberculosis together were observed in 0.4 per cent. of the cases. The abdominal findings—tenderness in the region of the appendix (2.3 per cent.), weak inguinal rings (5.9 per cent.), and inguinal hernia (5.1 per cent.)—will be of special interest because they are not ordinarily shown in collections of medical statistics.

"The facts for the urinalyses are of value. Albumin in slight trace was discovered in 12.2 per cent., in definite trace in 2.3 per cent., and in marked amount in 0.8 per cent. of the examinations. A 'trace' of sugar was reported in 3.4 per cent. of the specimens and a marked amount (by quantitation) in 0.4 per cent. of the specimens.

"The focal infections play an important part in the findings. Enlarged septic or buried tonsils were found in 26 per cent. of the persons examined. A definite pyorrhea was observed in every twentieth case; carious teeth or septic roots in 8.5 per cent. 'Heavy dentistry,' where further *x*-ray examinations were advised, showed up in 42 per cent. of the persons examined."

Table 35 (page 142) has been prepared from data published by Dr. Eugene Lyman Fisk, Medical Director of the Life Extension Institute. These figures are more or less unique because they are based upon most careful examinations (including *x*-ray, laboratory, and expert medical diagnostic facilities). They apply to females as well as to males and indicate the *severity* of the physical defects found.

The unusually consistent character of these findings

TABLE 35

ANALYSIS OF TYPICAL INDUSTRIAL, COMMERCIAL, AND INSURANCE GROUPS

(Figures derived from more than 10,000 cases)

Impairment.	Industrial:		Commercial:		Life insurance: men and women, average age 37, per cent.
	Men, average age 34, per cent.	Women, average age 25, per cent.	Men, average age 26, per cent.	Women, average age 26, per cent.	
No physical impairment reported—no modification of living habits required	0	0	0	0	0
Slight physical impairment or defect requiring observation or hygienic guidance	10	23	10	12	6
Moderate physical impairment or defect requiring some form of hygienic guidance or minor medical, dental, or surgical treatment	41	54	52	58	63
Moderate physical impairment or defect, medical supervision or treatment advised in addition to hygienic guidance	35	19	27	21	21
Advanced physical impairment or defect requiring systematic medical supervision or treatment	9	4	9	9	7
Serious physical impairment or defect urgently demanding immediate attention	5	0	2	0	3

(they have been further confirmed[1]) and the serious reflections which they cast upon the physical condition of adult populations are not surprising in the light of the data already quoted. They stand as an indictment of the deleterious influences which the act of living exerts upon civilized man. They present a challenge to those medical and social groups which are devoting their efforts

[1] Vide the findings of the United States Public Health Service Examinations of Post Office Employees, reported by the Life Extension Institute, February, 1923.

to the betterment of man's health, a challenge which cannot be denied.

It has been the traditional procedure to measure the efficacy of public health work in terms of changing rates of mortality. In a measure this practice was based upon rational *a priori* grounds. In part, however, it was due to the lack of adequate statistical evidences of the incidence of morbidity. It is becoming apparent now that efforts to improve the health of man are being focussed upon the causes of *morbidity* rather than upon the immediate causes of *mortality*. It is becoming increasingly clear from year to year that morbidity (except such outstanding cases as morbidity from typhoid fever, malaria, and a scant few other causes) is alarmingly extensive and is not markedly diminishing. Accurate statistics of morbidity and physical defects must be the corner-stone upon which will be founded in the future a rational program for improving the public's health. The need for these statistics is acute. The workers in the field, in the office, and in the laboratory who contribute to this field of statistical literature provide the groundwork for the public health program of the coming decades.

CHAPTER VII

MORTALITY

The Span of Life.—Perhaps the oldest recorded standard for mortality statistics is the one given to us by David when he set three score years and ten as the span of man's life. But progress comes by contradiction. A distinguished sanitarian declared recently that the prophecy of David was uttered in a moment of temporary pessimism and that a more appropriate starting-point in these hopeful days of public health and social welfare work is contained in the earlier prophecy, in the sixth chapter of Genesis:

"And the Lord said, my spirit shall not always strive with man, for that he also is flesh; yet his days shall be an hundred and twenty years."

It will not be long after we have entered this discussion of the statistics of deaths before we shall have learned that we have not yet attained the more popular "three score years and ten," that the road man must climb ere he reach the six or even a five score mark is long and toilsome—if it be attainable.

The Expectation of Living.—In the United States today each newborn infant has an even chance of living approximately forty-five to fifty years. This is what is

termed the "expectation of life," and it varies for male and females, for whites and for negroes, for persons living in urban and in rural areas, and with many other factors. Two score years and ten is an *approximately* accurate figure. In Table 36 data are presented which show the expectation of life at birth and at the ages thirty-two and sixty-two for white and negro persons in the original Registration States.

TABLE 36

EXPECTATION OF LIFE FOR WHITE AND NEGRO MALES AND FEMALES IN THE ORIGINAL REGISTRATION STATES: 1901, 1910, 1920

Population.		Expectation of life (years) at age: 0	32	62
White males....	1901	48.2	33.4	13.2
	1910	50.2	33.3	12.9
	1920	54.0	34.9	13.4
White females...	1901	51.1	35.0	14.0
	1910	53.6	35.4	13.7
	1920	56.3	36.1	14.0
Negro males....	1901	32.5	28.0	11.7
	1910	34.0	26.2	10.9
	1920	40.1	28.5	11.4
Negro females...	1901	35.0	29.4	12.7
	1910	37.7	28.3	12.0
	1920	42.2	28.8	12.1

It is clear from these figures that among negroes as well as among whites and throughout the span of life females are longer lived than males. Also it appears that the expectation of living of both males and females, white and colored, at birth and of white females at age thirty-two was higher in 1920 than in 1910 and higher in 1910 than in 1901. For all other groups the expected

remaining life span at ages thirty-two and sixty-two was *lower* in 1910 than in 1901 and higher in 1920 than in 1910. These figures indicate some of the reasons why sanitarians have felt encouraged about the control of infant and young adult mortality, and why they were very much distressed, in the years preceding 1920, over the increasing mortality rates prevailing among adults. The 1920 figures have reassured many and made it appear questionable that adult mortality is increasing.

The Attainable Expectation of Life.—From the experiences of many localities where particularly low mortalities prevail Dr. Dublin has calculated that if present-day knowledge of preventive medicine and public health were completely applied to the conservation of human life the expectation of living would be 64.75 years at birth (three score years and *five*); 59.02 at age ten; 41.06 at age thirty; 24.08 at age fifty, and 9.17 at age seventy. These expectations are greater by approximately ten years at birth, six years at age thirty, and 2.5 years at age sixty than the expectations actually occurring among white persons in 1920, and are, of course, much higher than the 1920 expectations for negroes.

The Registration of Deaths.—In an earlier chapter it was pointed out that the registration of still-births is kept separate from births and deaths. This is an important procedure. An exception to this general practice

should always be accompanied by a statement to that effect.

The registration of deaths is of great legal and commercial importance for several reasons, chief of which are: the protection of the persons and property of individuals, particularly with respect to pensions, life insurance, titles, and rights to inheritances; the prevention of crime by the legal requirement of the certification of a death prior to the burial of a body; the development of public health and social welfare programs and the measurement of the results of such welfare work. The vital statistics of death serve as a guide to the health department officer, the nursing association director, the nurse, the health center or the social service worker.

The Registration Area for Deaths.—In the United States the ultimate source of the statistics of death is the death certificate. The completeness and the accuracy of these statistics are dependent upon the proportion of all deaths which are reported, upon the accuracy with which the death certificates are filled out, and upon the accuracy with which the information on the certificate is compiled for statistical analysis. Accurate statistics of mortality are not yet available for the whole of the country. The United States Census Bureau confines its mortality data to those states which have been admitted into the Registration Area for deaths. States are "admitted" when they have made

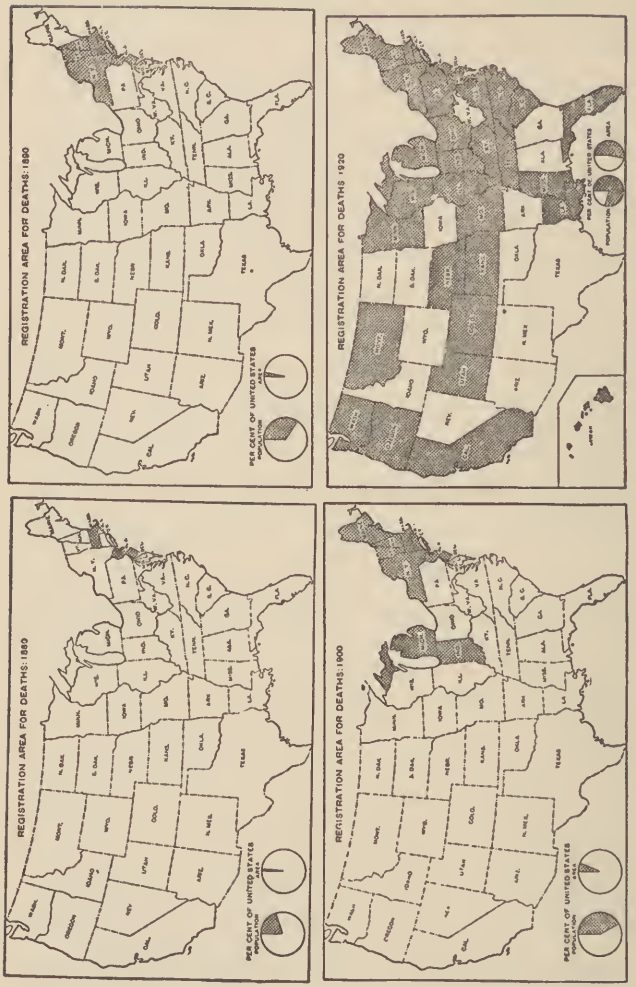


Fig. 17.—Growth of the registration area for deaths (1880–1920). Note: In addition to the registration states (stated in the maps) the registration area included certain cities in non-registration states (from Mortality Statistics, 1920, Bureau of the Census).

adequate legal provisions for the compulsory registration of accurate and complete death certificates and when

they can demonstrate to the satisfaction of Census Bureau officials that 90 per cent. or more of all deaths which occur are being registered. The growth of the United States Registration Area for Deaths is indicated in Fig. 17 (page 148) and in Table 37.

TABLE 37

GROWTH OF THE UNITED STATES REGISTRATION AREA FOR DEATHS: 1880–1920

Census year.	Population of United States.	Percentage of United States population in Registration Area.
1880	50,155,783	17.0
1890	62,622,250	31.4
1900	75,994,575	40.5
1910	92,309,348	58.3
1920	105,710,620	81.1

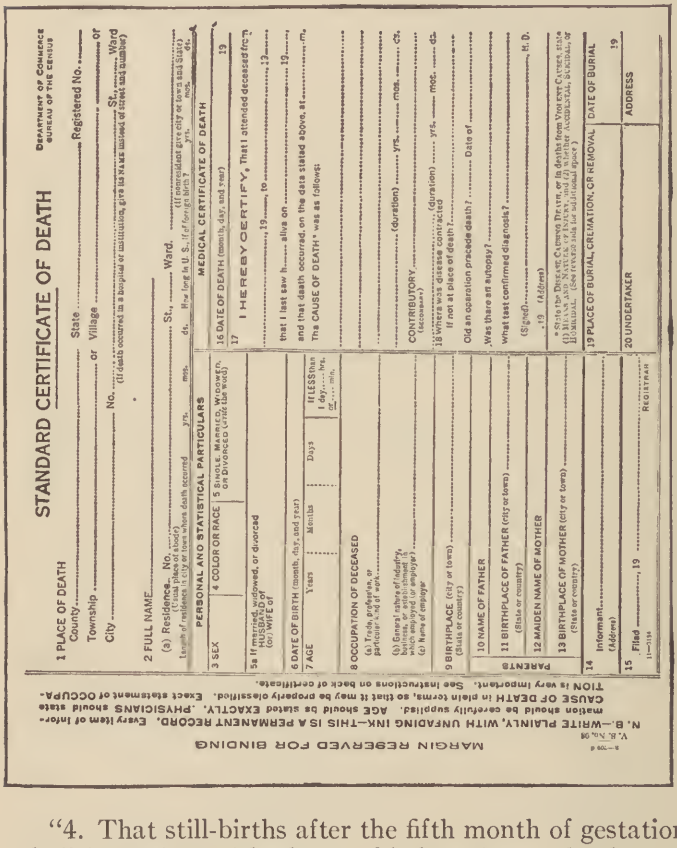
The Registration Area for Deaths must not be confused with the corresponding area for births (described in Chapter III). Statistics for the two will be kept separate, one from the other, by the Census Bureau until they have grown to include the same states and cities.

The Model Law for Vital Statistics.—The legal requirements of the Census Bureau for the reporting of deaths are included in the following provisions of the so-called Model Law for Vital Statistics:

"1. That the State Board of Health shall have charge of the registration of deaths.

"2. That there shall be a registrar of vital statistics who shall have immediate charge of these registrations in each registration district in the state.

"3. That no burial permit shall be issued until a complete and accurate certificate of death has been filed for the body.



STANDARD CERTIFICATE OF DEATH

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

1 PLACE OF DEATH
County ..... State ..... Registered No. .....
Township ..... or Village ..... or
City ..... No. ..... St. ..... Ward
(If death occurred in a hospital or institution, give its NAME instead of street and number)

2 FULL NAME .....
(a) Residence. No. ..... St. ..... Ward.
(Usual place of abode)
Length of residence in city or town where death occurred ..... yrs. ..... mos. ..... ds. How long in U. S., if of foreign birth? ..... yrs. ..... mos. ..... ds.
(If nonresident give city or town and State)

PERSONAL AND STATISTICAL PARTICULARS

3 SEX | 4 COLOR OR RACE | 5 SINGLE, MARRIED, WIDOWED, OR DIVORCED (write the word)

5a If married, widowed, or divorced HUSBAND of (or) WIFE of

6 DATE OF BIRTH (month, day, and year)

7 AGE | Years | Months | Days | If LESS than 1 day, ... hrs. or ..... min.

8 OCCUPATION OF DECEASED
(a) Trade, profession, or particular kind of work .....
(b) General nature of industry, business, or establishment in which employed (or employer) .....
(c) Name of employer .....

9 BIRTHPLACE (city or town) ..... (State or country)

10 NAME OF FATHER

11 BIRTHPLACE OF FATHER (city or town) ..... (State or country)

12 MAIDEN NAME OF MOTHER

13 BIRTHPLACE OF MOTHER (city or town) ..... (State or country)

14 Informant ..... (Address)

15 Filed ..... 19 ..... REGISTRAR

MEDICAL CERTIFICATE OF DEATH

16 DATE OF DEATH (month, day, and year) 19

17 I HEREBY CERTIFY, That I attended deceased from ..... 19 ..... to ..... 19 .....
that I last saw h..... alive on ..... 19 .....
and that death occurred, on the date stated above, at ..... m.
The CAUSE OF DEATH* was as follows:

..... (duration) ..... yrs. ..... mos. ..... ds.

CONTRIBUTORY ..... (Secondary)

18 Where was disease contracted ..... yrs. ..... mos. ..... ds.
If not at place of death? .....

Did an operation precede death? ..... Date of .....

Was there an autopsy? .....

What test confirmed diagnosis? .....

(Signed) ..... M. D.
..... 19 ..... (Address)

* State the DISEASE CAUSING DEATH, or in deaths from VIOLENT CAUSES, state (1) MEANS AND NATURE OF INJURY, and (2) whether ACCIDENTAL, SUICIDAL, or HOMICIDAL. (See reverse side for additional space.)

19 PLACE OF BURIAL, CREMATION, OR REMOVAL | DATE OF BURIAL 19

20 UNDERTAKER | ADDRESS

MARGIN RESERVED FOR BINDING

N. B.—WRITE PLAINLY, WITH UNFADING INK—THIS IS A PERMANENT RECORD. Every item of information should be carefully supplied. AGE should be stated EXACTLY. PHYSICIANS should state CAUSE OF DEATH in plain terms, so that it may be properly classified. Exact statement of OCCUPATION is very important. See instructions on back of certificate.

Fig. 18.—The standard death certificate.

"4. That still-births after the fifth month of gestation shall be registered both as a birth and as a death, and kept separate from other births and deaths.

"5. That the 'standard certificate of death' or one containing its essential items, shall be used. (See Fig. 18.)

"6. That the medical certificate shall be signed by the physician in attendance at the time of death.

"7. That in case of death occurring without medical attendance it shall be the duty of the undertaker to notify the local registrar.

"8. That no person in charge of places of interment shall permit interment or other disposition of any body unless it is accompanied by a burial, removal, or transit permit."

The mortality statistics which are collected by local registrars are compiled by the statistical bureaus of each state and then by the Census Bureau. The results of the compilation for the Registration Area for Deaths by the Census Bureau are published each year in a volume of Mortality Statistics. These, as well as other Census Bureau publications, are kept on file in libraries and statistical offices and are obtainable from the Census Bureau in Washington. In addition, special reports on mortality statistics are issued from time to time on such special topics as mortality from cancer or from influenza. A large part of the statistics given in this chapter are taken from these annual and special reports of the United States Census Bureau.

Errors in Mortality Statistics. Incompleteness.—One of the outstanding errors in mortality statistics is their incompleteness. This is due to the fact that even in communities with up-to-date statistical laws and offices not all of the deaths are registered. In part this is due simply to failure of registration and in part to the

complicating problems which arise when deaths of individuals occur when they are away from their ordinary residences or when they are in institutions for the care of the sick. Many deaths which occur in institutions are undoubtedly chargeable to the town or country in which the death occurred. Others, probably a larger portion, should be charged against the community in which the deceased had lived prior to his entrance into an institution. No adequate system for properly charging back institutional deaths to the proper places of residence has been devised as yet, and to avoid the chance of duplicating death registries the United States Census Bureau still adheres to the plan of charging deaths against the state, city, or county in which they occur. Thus, communities with large institutions in which people die have unusually high mortality rates.

Another common source of error in mortality statistics is the inaccurate statement of information on the death certificates. Age of the deceased, place of residence, and occupation are very commonly given inaccurately.

The Diagnosis of Cause of Death.—One of the most important items of information on a death certificate is the statement of cause of death. Also, it is the one in which there is the greatest opportunity for error. Some of the statistical devices which are utilized in attempts to standardize and to render more accurate statement of cause of death will be discussed in some detail below and in the following chapter. Suffice it here to point

out that no matter how difficult it is to determine the exact cause of death or the nature of the terminal illness, a statement of the cause of death must be given on the death certificate by the attending physician or by the person registering the death. Either because of the difficulty of diagnosis or sometimes because of the conscious desire to misstate the cause of death to avoid odium or to shield the family of the deceased, or often because two or more pathologic conditions have operated simultaneously to cause death, the statement of cause of death is liable to frequent error. An attempt to confirm the causes of death—as given at time of death—by careful autopsy was made by Dr. Richard C. Cabot in 1912 on some 3000 cases. His results are given in Table 38 (page 154).

The figures show how markedly the accuracy of stated causes of death varies, from 95 per cent. accuracy for diabetes mellitus to 16 per cent. in acute nephritis. And these were hospital cases in which diagnosis is ordinarily more accurate than in general practice. In the ten years which have elapsed since this study was made the accuracy of diagnosis has probably increased, particularly with respect to a number of the diseases in the lower half of Dr. Cabot's list.

Dr. Haven Emerson made a careful study in 1916 of the reliability of statements of cause of death from the clinical and pathologic viewpoints. He came to the conclusion that of the 189 titles which are accepted in

TABLE 38

THE ACCURACY OF DIAGNOSIS OF CAUSES OF DEATH IN 3000 CASES FOLLOWED BY AUTOPSIES

Cause of death.	Percentage correct diagnosis.
Diabetes mellitus	95
Typhoid	92
Aortic regurgitation	84
Cancer of colon	74
Lobar pneumonia	74
Chronic glomerulonephritis	74
Cerebral tumor	72.8
Tuberculous meningitis	72
Gastric cancer	72
Mitral stenosis	69
Brain hemorrhage	67
Septic meningitis	64
Aortic stenosis	61
Phthisis, active	59
Miliary tuberculosis	52
Chronic interstitial nephritis	50
Thoracic aneurysm	50
Hepatic cirrhosis	39
Acute endocarditis	39
Peptic ulcer	36
Suppurative nephritis	35
Renal tuberculosis	33.3
Bronchopneumonia	33
Vertebral tuberculosis	23
Chronic myocarditis	22
Hepatic abscess	20
Acute pericarditis	20
Acute nephritis	16

the international List of Causes of Death (which will be described below), "23 are not to be accepted as reliable without autopsy; 53 are to be accepted only if specific supporting data have been obtained upon which diagnosis was based; 113 are to be accepted as reliable

without autopsy or other verification. Of the total mortality of New York City in 1914, 3.8 per cent. fall under the first classification (not to be accepted as reliable without autopsy), 37.4 per cent. fall under the second classification (to be accepted only if specific supporting data have been obtained upon which diagnosis was based), and . . . 58.8 per cent. fall under the third classification (to be accepted as reliable). That is, tested by clinical and pathologic standards, 41.2 per cent. of recorded deaths are from questionable causes." Dr. Emerson proposed that the acceptable groups should be separated from the questionable to improve the value of deductions to be made from statistical studies. This suggestion has not yet been adopted.

Correcting Statements of Cause of Death.—The Census Bureau, from time to time, sends out to physicians whose names appear on death certificates queries for additional information concerning the cause of death. On the basis of the replies received the bureau has published Table 39 (page 156) which indicates the changes in diagnosis of cause of death for the mortality returns of 1920.

A single glance over this table will indicate how commonly statement of the cause of death may be erroneous and with how large a grain of salt mortality statistics by cause of death must be taken.

Autopsies and Tests to Confirm Cause of Death.—In

TABLE 39

CAUSES OF DEATH PRINCIPALLY AFFECTED BY QUERIES SENT TO PHYSICIANS, 1920

Cause of death.	Percentage change by queries.[1]
Measles	+ 4.1
Whooping-cough	+ 3.6
Influenza	+ 2.2
Purulent infection and septicemia[2]	−11.9
Tuberculosis of the lungs	+ 0.2
Tuberculous meningitis	+ 2.5
Syphilis	+ 3.9
Gonococcus infection	+47.4
Other general diseases[2]	− 4.9
Encephalitis[2]	− 2.1
Meningitis, cerebrospinal meningitis[2]	−18.8
Cerebrospinal fever	+73.3
Other diseases of the spinal cord	+ 7.6
Cerebral hemorrhage, apoplexy[2]	+ 1.3
Softening of the brain[2]	− 2.7
Paralysis (without specified cause)[2]	−19.8
General paralysis of the insane[2]	− 2.3
Convulsions (non-puerperal)[2]	−19.9
Convulsions of infants[2]	− 8.6
Bronchopneumonia[2]	− 1.8
Pneumonia (undefined)[2]	−24.9
Lobar pneumonia	+ 2.5
Pulmonary congestion, pulmonary apoplexy[2]	−11.4
Diseases of respiratory system (except tuberculosis)[2]	−13.5
Other diseases of the stomach (cancer excepted)[2]	− 6.4
Diarrhea and enteritis (under two years)	+ 2.2
Simple peritonitis (non-puerperal)[2]	−13.0
Acute nephritis[2]	− 6.1
Salpingitis, other diseases of female genital organs[2]	−13.5
Puerperal septicemia	+ 2.3
Puerperal albuminuria, and convulsions	+ 3.6
Premature birth	+ 0.9
Congenital debility, atrophy, marasmus, etc.[2]	− 8.4
Ill-defined organic diseases[2]	−11.9
Not specified or ill-defined[2]	− 1.5

[1] A minus sign (−) denotes decrease, a plus sign (+) increase.

[2] Title under which one or more unsatisfactory terms were queried.

the United States comparatively few autopsies are conducted to confirm the cause of death. Among those states in the Registration Area in which the conductance of an autopsy is reported on the death certificate, Minnesota headed the list in 1920 with autopsies in only 4.2 per cent of all deaths! For a total of 21 states in the Registration Area 1 per cent. of all deaths were followed by autopsies and 4 per cent. were subjected to some test or other, but no autopsy. Deaths from mycoses, diseases of the spleen, and plague were followed by autopsy more commonly than any others (10 per cent.).

Non-resident Deaths.—Another source of error in statistics of mortality as well as of other vital facts is the migration of individuals and of families from one place to another. The complicating effects of this phenomenon upon statistical studies can only be mentioned here as indicating the nature of some of the sources of error in mortality statistics.

Deaths and Death-rates.—It was indicated above that for the United States we have reasonably accurate statistics of death only for that portion of the country which is included in the Registration Area. In 1920—the latest year for which the statistics have been published—there were approximately 1,150,000 deaths in this area, which included 81 per cent. of the country's population. It follows that in the United States there were in the same year about 1,400,000 deaths among

the 106,000,000 persons. To grasp more accurately the meaning of these figures we will have recourse to the use of *death-rates* in the same manner in which (in Chapter III) we used *birth-rates* to study the statistics of birth.

Crude Death-rates.—A *death-rate* (for reasons which will appear shortly, called the "crude" death-rate) is a statement of *the number of deaths in a group of 1000, 10,000, 100,000, or 1,000,000 persons.* Most commonly *deaths per 1000* is used. The method of making the calculation of a death-rate is indicated by the formula:

$$\text{(Crude) death-rate} = \frac{\text{Number of deaths}}{\text{Population}} \times 1000 \cdot$$

In calculating death-rates it must always be remembered that the *population* figure used, to be comparable with the *number of deaths*, must apply to the same period of time as the deaths. Deaths are usually given in statistical tables for the calendar year and populations as of the census date. Populations should, therefore, be corrected to apply to June 30th or deaths to apply to the twelve-month period centering about the census date.

Trend of the Death-rate in the United States.—In the United States the magnitude of the crude death-rate and the changes in it which have occurred in the last twenty-one years for which statistics are available are shown in Table 40:

TABLE 40

DEATH-RATES FOR THE REGISTRATION AREA OF THE UNITED STATES, 1900–1921

Year.	Death-rate per 1000 persons.	Year.	Death-rate per 1000 persons.
1900	17.6	1911	14.2
1901	16.5	1912	13.9
1902	15.9	1913	14.1
1903	16.0	1914	13.6
1904	16.5	1915	13.6
1905	16.0	1916	14.0
1906	15.7	1917	14.3
1907	16.0	1918	18.1
1908	14.8	1919	12.9
1909	14.4	1920	13.1
1910	15.0	1921	11.6

Fig. 19.—The trend of the death-rate in the Registration Area of the United States: 1900–1921.

With the exception of the rate for the year 1918, the year in which the influenza epidemic took its great toll

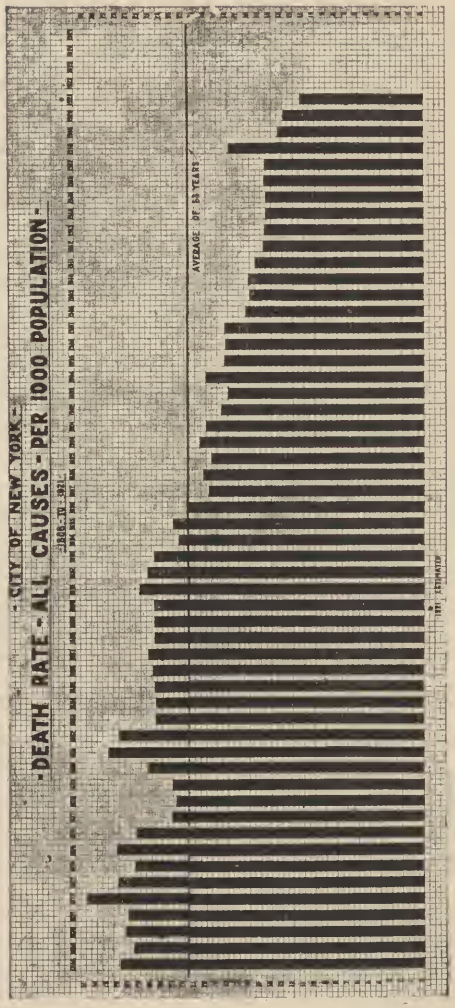


Fig. 20.—The declining death-rate in New York City, 1868–1921. (From the Condensed Annual Report, Department of Health, New York City, 1921.)

of lives, the general tendency of the death-rate to decline is evident. The trend of the death-rate in New

York City for the years 1868–1921 is indicated in Fig. 20.

Death-rates in United States and Other Countries.— Some interesting facts about the death-rates for the United States appear when we compare them with the corresponding rates for other countries. The latest available figures apply to the year 1919. That the crude death-rate for the United States was higher than some and lower than other foreign rates is indicated in Table 41.

TABLE 41

DEATH-RATES FOR THE UNITED STATES AND FOR CERTAIN OTHER COUNTRIES: 1900, 1905, 1910, 1915, 1917, AND 1919

Country.	Crude death-rates per 1000 persons: 1900.	1905.	1910.	1915.	1917.	1919.
United States[1]	17.6	16.0	15.0	13.6	14.3	12.9
New Zealand	9.4	9.3	9.7	9.1	9.6	9.5
Australia	11.8	10.9	10.4	10.7	9.8	12.8
Sweden	16.8	15.6	14.0	14.6[2]	13.4	14.4
England and Wales	18.2	15.3	13.5	15.7[3]	14.4[3]	13.7
Germany	22.1	19.8	16.2	15.1[2]	16.1[2]	
Ireland	19.6	17.1	17.1	17.6	16.6	17.6
France	21.9	19.6	17.8	19.1[4]	18.6[4]	19.1[4]
Italy	23.8	22.0	19.9	20.4	19.2	19.0

The trend of the death-rates has been generally in the direction of a decline. The differences between countries tend, however, to remain much the same year after year. They are fixed by essentially fixed hereditary as well as by variable environmental factors peculiar

[1] These rates apply to the Registration Area for Deaths.

[2] The figure is provisional.

[3] Applies to the civilian population only.

[4] The figures relate to 77 "*departements*" which were not invaded.

to the peoples and their countries. Of course some of the differences between countries indicated by Table 41 are due to differences in the age and sex proportions in the populations.

Death-rates in Large Cities.—Differences in the crude death-rates for certain large cities of the world, as shown by a recent compilation, are given in Table 42:

TABLE 42

RATES OF MORTALITY IN CERTAIN LARGE CITIES: 1920

City.	Death-rate per 1000 persons.
Amsterdam	11.1
Birmingham	12.5
London	12.7
New York	*12.9*
Manchester	13.0
Edinburgh	13.2
Dusseldorf	13.2
Bradford	13.3
Hamburg	13.8
Cologne	14.1
Leipzig	14.2
Paris	14.8
Glasgow	15.3
Berlin	16.0
Liverpool	16.4
Vienna	18.6
Florence	20.5

The death-rates range from about 11 for Amsterdam to nearly 20.5 for Florence. In each 1000 nearly twice as many persons die in the latter as in the former city. New York City—which has one of the lowest death-rates of any of the large cities of the United States—is well up near the top of the list.

Specific Death-rates.—So far we have been dealing only with "crude" death-rates. Further analysis of the problem of mortality demands the use of more refined indexes of mortality, called "specific" death-rates. Instead of taking all deaths and whole populations together in calculating rates, we shall, for example, split up our deaths and our populations into a group for males and a group for females, a group of deaths and of persons of one age or of another age, deaths from a certain cause or occurring in a certain month of the year or among persons working in a specific group of occupations, and calculate *specific death-rates* for these groups. Thus we shall learn something about the part which such factors as sex, age, specific causes of death, season of the year, or occupation play in the causatoin of mortality.

Urban and Rural Death-rates.—Over and over again we hear people talking—or perhaps we express opinions ourselves—about the relative healthfulness of "the country" and "the city." In statistical parlance we prefer to use the more accurate terms "urban" and "rural" to describe the same geographic parts. Table 43 (page 164) has been prepared to cast some light upon the "relative healthfulness" problem by presenting death-rates for the urban and rural parts of the Registration Area from 1901 to 1911.

An examination of these figures brings out some interesting facts. In every case the death-rate for cities

TABLE 43

DEATH-RATES FOR URBAN AND RURAL AREAS IN THE UNITED STATES, 1901–1911

Area.	Death-rates per 1000 persons					
	1901–1905.	1906–1910.	1908.	1909.	1910.	1911.
States in the Registration Area.	15.9	15.0	14.7	14.2	14.7	13.9
Cities in the Registration Area..	17.4	16.3	15.9	15.4	15.9	15.1
Rural Part of Registration States	14.1	13.4	13.3	13.0	13.4	12.7

was higher than the death-rate for rural parts or for the states as a whole. Also there had been a generally consistent decline in the death-rates for each of the groups from 1901 to 1911. What do these figures tell us about the relative healthfulness of the cities and the rural areas? These death-rates are all "crude" and hence are comparable only if the populations to which they apply are comparable. Does a higher death-rate for cities mean that the cities are less healthful places in which to live? Possibly. Does it mean that there were larger proportions of infants or of old persons in the populations of cities than of rural places? Yes and no. In Chapter III it was pointed out that the birth-rate was higher in urban districts than in the rural part of the United States Registration Area for Births. A higher birth-rate means a larger proportion of infants and of young persons in the city, probably a larger number of infant deaths and hence a higher general death-rate. The 1910 Census showed also a smaller proportion of young persons (under fifteen years) and a larger proportion of adults (fifteen to forty-five years)

in the cities than in the urban places. These differences in age distribution also mean higher death-rates for the cities because—as will be pointed out below in the discussion of mortality for different ages of life—the young persons under fifteen, of whom there is a larger proportion in the rural populations, have the lowest death-rates of any persons. It therefore follows that the higher death-rates of people in the cities as compared to those in the "country" may have nothing or very little to do with the place of residence and may be merely the effect of differences in the age distributions of the populations. The fact remains, however, that as the populations were constituted in the years 1901–1911, for which the figures in Table 43 apply, in every 1000 persons a larger number died each year in the cities than in the rural places of the same states.

Death-rates of White and Colored Males and Females.—In the United States we have continually with us a nearly unique problem that we have in large areas an important minority of negroes in the population. And one of the first facts which requires examination in attempting to arrive at an understanding of mortality problems is the comparative mortality among white and colored persons. That important differences exist between these two groups with respect to their susceptibility to death is brought out by the data in Table 44 which describes the mortality experience of the Metropolitan Life Insurance Company's Industrial Ex-

perience (an average of about 9,000,000 persons per year) for the years 1911–1916.

TABLE 44

DEATH-RATES OF WHITE AND COLORED MALES AND FEMALES. EXPERIENCE OF THE METROPOLITAN LIFE INSURANCE COMPANY: 1911–1916

Color and sex.	Death-rate per 1000 persons.
Total	11.8
White	11.0
Males	11.8
Females	10.4
Colored	17.2
Males	17.6
Females	16.9

This analysis of deaths by race and sex brings out a number of important facts. It is readily evident that the mortality of colored persons is very much higher than that of white persons (17.2 compared to 11 deaths per 1000). For both white and colored persons the males suffer from higher mortalities than the females. It follows, then, that in any communities in which there are an unusually large number of males or of colored persons the crude death-rate will be unusually high. Further analysis in the next chapter, particularly of the specific causes of death, will cast further light upon the nature of the excessive mortality of negroes. A considerable part of it is undoubtedly attributable to the lower economic and social level of the negro.

Nativity and Race.—Not only such broad differences as exist between white and colored persons, but less

striking differences in nativity or nationality bear a distinct and important relationship to mortality. In statistical studies of this problem there is sometimes an unnecessary and sometimes an unavoidable confusion between racial and national (politico-national) relationships. The data in Tables 45 and 46 are taken from a

TABLE 45

THE RELATIONSHIP BETWEEN NATIVITY, PARENTAGE, AND MORTALITY AMONG WHITE MALES AND FEMALES IN NEW YORK STATE, 1910

Nativity.	Death-rate per 1000 persons: Males.	Females.
Native born:		
Of native parentage	13.8	12.4
Of foreign or mixed parentage	17.2	13.9
Foreign born	17.1	16.2

TABLE 46

MORTALITY OF PERSONS OF DIFFERENT NATIVITIES LIVING IN NEW YORK STATE IN 1910

Nativity.	Death-rate per 1000 persons: Males.	Females.
Native	13.8	12.4
Italian	12.9	13.7
Russian	13.1	12.3
Austro-Hungarian	14.3	12.4
English, Scotch, and Welsh	16.6	15.8
German	17.9	14.4
Irish	25.9	23.5

study of the death-rates among native and foreign-born persons and in various race stocks of New York State in 1910, made by Dr. L. I. Dublin. This is one of the few careful studies which have been made along this line.

These figures bring out very clearly what every sta-

tistician or public health nurse and every social worker who studies mortality in every-day experience knows, that mortality is higher among males than among females, and among foreign-born than among native-born persons in the general mixed population of the United States.

It is to be remembered that all of these people living in New York State were subject to essentially the same environment and only to such differences in conditions of living as are incidental to their social and economic planes and to the traditional methods of housing, clothing, diet, etc., which they have brought with them from their lands of birth. When people migrate from one country to another, for a generation at least, they carry their home environment as well as their heredity with them. In the table the figures have been arranged with the death-rates for the native-born persons at the head of each column, and below the races are arranged with the one having the lowest male mortality at the head and the one with the highest male mortality at the foot of the list. This arrangement brings out some striking facts:

1. It is seen that for native persons (as was pointed out above) males have higher mortality rates than females.
2. Two of the foreign race groups—the Italians and the Russians—have lower male mortality rates than the native males, and four—the Austro-Hungarians, the English, Scotch and Welsh, the Germans and the

Irish—have higher male mortality rates. The last named, the Irish males, had a mortality in New York State in 1910 approximately twice as high as that of the native males!

3. Although Italian males had a lower death-rate than native males, Italian females had a higher rate than native females. Also, Italian females had a higher death-rate than Italian males.

4. The sequence of the death-rates in order of magnitude is otherwise not the same for females as for males.

All of these indications introduce points of serious practical importance in the conduct of welfare and nursing work which will appear perhaps more strongly when the principal causes of death in these different racial groups have been discussed.

Specific Death-rates for Age and Sex.—In our discussion of color, race, nativity, and sex thus far we have had illustrations of specific death-rates. Similarly, we may utilize specific death-rates to great advantage in studying mortality by age and sex. To calculate a death-rate for a specific age group, *i. e.*, for persons twenty to thirty years of age, we may use the general formula in the following manner:

$$\text{Specific death-rate for persons twenty to thirty years of age} = \frac{\text{Deaths of persons twenty to thirty years}}{\text{Number of persons twenty to thirty years}} \times 1000$$

Such a death-rate may be further refined to be specific not only for *age* but also for a *sex* group by using, in the calculation, the number of deaths in the age and sex

group and dividing by the number of persons of that age and sex.

For the Registration Area of the United States we have reasonably accurate information as to the total number of deaths and the number of deaths among persons of each age. The additional population facts—the total number of persons of each age in the population—which are needed to calculate the death-rates specific for ages are known accurately for census years and are known only by estimation for intercensus years. The data presented in Table 47 apply to the year 1911 and

TABLE 47

DEATH-RATES OF ALL PERSONS, OF MALES AND OF FEMALES, AT ALL AGES OF LIFE

(Original Registration States, 1911)

Age period.	Death-rate per 1000 persons: Both sexes.	Males.	Females.
All ages	14.9	15.8	14.0
Under 1 year	125.5	138.6	112.1
Under 5 years	36.6	39.8	33.3
5– 9 years	3.2	3.4	3.1
10–14 "	2.2	2.4	2.1
15–19 "	3.5	3.7	3.3
20–24 "	5.0	5.3	4.7
25–34 "	6.3	6.7	6.0
35–44 "	9.4	10.4	8.3
45–54 "	14.5	16.1	12.9
55–64 "	28.4	30.9	26.0
65–74 "	58.3	61.6	55.1
75 years and over	143.0	147.4	139.2

are reasonably reliable. They were computed for the "Original Registration States," *i. e.*, those states which had been in the Registration Area in 1900, and include

statistics for Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Indiana, Michigan, and the District of Columbia, with a total population of a little over 24,000,000 persons of both sexes.

The first important observation to be made upon these figures concerns the relation of the death-rates in each column. The comparatively enormous mortality of infants (persons *under one year*) stands out abruptly above all other facts. It has been dealt with more fully in Chapter IV, Infant Mortality. The observation applies equally well to "both sexes," "males," and to "females." The next fact to be observed in these figures is the high but declining mortality of children *under five years* and the minimum death-rates of childhood, adolescence, and youth (five to nineteen years). Beginning with the age twenty the death-rates increase and they continue to increase until the maximum rates are observed at the highest ages of life.

The death-rates for the two sexes show in each age group a higher mortality among males than among females. Another way of stating this same fact is that males have higher and females have lower death-rates than the two sexes combined. All of these facts are portrayed in the graph of the table (Fig. 21, page 172) by the curves for the specific death-rates of males and females by age.

From this brief discussion of Table 47 the influence

of age distribution of a population upon the general crude death-rate becomes evident. Because of the enormously high mortality which occurs in the earliest and in the latest years of life, any population with an unusually large number of infants or of old adults—other

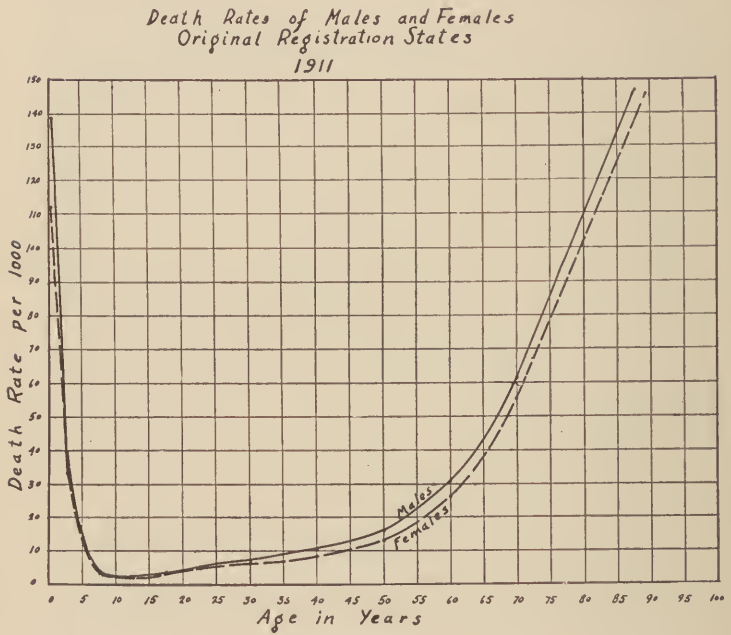


Fig. 21.

things being normal—will have an unusually *large* death-rate; similarly, any population with an abnormally large group of children or young adults will have an unusually *low* death-rate. A population with a high

proportion of males will have a high and one with a high proportion of females a low, crude death-rate. Therefore, unless two communities are known to have comparatively similar distributions of old and young, of males and females, comparison of their crude death-rates may tell nothing about the relative healthfulness of the two places or of their populations.

The Standardization of Death-rates.—There is a statistical procedure termed "standardizing death-rates" which is used for "correcting" or "adjusting" or "standardizing" crude rates, so that they will be comparable even for populations with slightly or markedly different proportions of persons of different ages or of different sexes. The principle of the procedure is simple enough. The age distribution (for "both sexes" or for "males" and "females" separately) for a particular or hypothetic community is taken as a "standard." It is customary to take a total of 1,000,000 persons and divide them according to the age distribution of persons in the "standard" population. This is known as a "standard million." The standard million of England and Wales for 1901 is used more commonly than any other. It is illustrated in Table 48 (page 174).

The procedure is then to determine what the death-rate for all ages would have been if community A, with its particular specific death-rates, had had the population distribution of the standard million. In Table 49 (page 174) the process is illustrated. There we have undertaken

TABLE 48

A "Standard Million," England and Wales, 1901

(Age and Sex Distribution of 1,000,000 Persons)

Age period.	Both sexes.	Males.	Females.
– 5	114,262	57,039	57,223
5– 9	107,209	53,462	53,747
10–14	102,735	51,370	51,365
15–19	99,796	49,420	50,376
20–24	95,946	45,273	50,673
25–34	161,579	76,425	85,154
35–44	122,849	59,394	63,455
45–54	89,222	42,924	46,298
55–64	59,741	27,913	31,828
65–74	33,080	14,691	18,389
75+	13,581	5,632	7,949
All ages	1,000,000	483,543	516,457

TABLE 49

Standardization of the Death-rate for the United States Registration Area, 1900

Age period. (1)	Death-rate. (2)	Population in thousands. (3)	Expected deaths (2) × (3). (4)
– 5 years	51.86	114.262	5,926
5– 9 "	5.08	107.209	545
10–14 "	3.25	102.735	339
15–19 "	5.19	99.796	518
20–24 "	7.36	95.946	706
25–34 "	8.74	161.579	1,412
35–44 "	11.21	122.849	1,377
45–54 "	16.58	89.222	1,479
55–64 "	29.58	59.741	1,767
65–74 "	60.22	33.080	1,992
75+ "	146.72	13.581	1,994
Total expected deaths			18,055

Total expected deaths in 1,000,000 persons = 18,055

"Standardized" death-rate—expected deaths in 1000 persons = 18.05

Crude death-rate = 17.55

to determine what the death-rate would have been in the Registration Area of the United States in 1900 if its population (both sexes) had been distributed according to the standard million. Column (1) lists the age periods. In column (2) we have set forth the actual specific death-rate for each age period. Column (3) is the distribution of 1,000,000 persons (England and Wales, 1901) in *thousands*.

It follows, then, that in the age period "–5 years," had the distribution of population been "standard," there would have been 114,262 persons in that age period of each 1,000,000 and there would have occurred 51.86 deaths in each 1000 of them. Therefore, the *expected* number of deaths among persons under five years of age is 51.86×114.262, or 5926. Similarly, by multiplying each specific death-rate by the corresponding population in thousands we obtain the number of deaths which would have occurred among persons in each age period in each 1,000,000 in the population. Now, if we sum all the expected deaths in column (4) we obtain the total number of deaths in each 1,000,000 persons which would have occurred in the Registration Area in 1900 if the population of the area had been distributed over the span of life in accordance with the standard 1,000,000. This total equals 18,055, or 18.05 deaths per 1000. This standardized death-rate is higher than the actual crude rate (17.55) by 0.50 deaths per 1000.

In a similar manner, death-rates for two or more

communities can be standardized against some common "standard million," not only for "both sexes," but separately for "males" and for "females." Furthermore, instead of the England and Wales standard, the age and sex distribution of one community may be used as the standard for another community with which a death-rate comparison is desired. The only caution to be observed is that whatever population is taken for a "standard" it must not have a markedly abnormal distribution of persons by age or sex.

Occupation and Mortality.—A study of the relation between occupation and mortality must be approached with extreme caution. If one wishes to find out merely the statistical facts about the relationship, the matter is simple enough. If, however, one wishes to draw conclusions from the statistics as to the influence of specific occupations upon the mortality of the persons engaged in them, the problem becomes exceedingly complicated and very much more difficult. Thus, if we compared the death-rates for persons in the Industrial Experience of the Metropolitan Life Insurance Company age for age, sex for sex, with the corresponding death-rates for the whole population of the United States we would find uniformly, or nearly uniformly, higher rates for the occupied than for the general population. Or, for example, in Table 50 are shown the average ages at death for males in certain occupations, taken from the experience of the Metropolitan Life Insurance Company

TABLE 50

AVERAGE AGE AT DEATH FOR NINETEEN OCCUPATIONS, METROPOLITAN LIFE INSURANCE COMPANY, 1911–1913

Occupation.	Average age at death.
Bookkeepers and office assistants	36.5
Enginemen and trainmen (railway)	37.4
Plumbers, gas-fitters, and steam-fitters	39.8
Compositors and printers	40.2
Teamsters, drivers, and chauffeurs	42.2
Saloon keepers and bartenders	42.6
Machinists	43.9
Longshoremen and stevedores	47.0
Textile mill workers	47.6
Iron molders	48.0
Painters, paper-hangers, and varnishers	48.6
Cigarmakers and tobacco workers	49.5
Bakers	50.6
Railway track and yard workers	50.7
Coal miners	51.3
Laborers	52.8
Masons and bricklayers	55.0
Blacksmiths	55.4
Farmers and farm laborers	58.5
All occupations	47.9

for about 94,000 deaths occurring in the years 1911, 1912, and 1913.

Comparison of the average age at the time of death for any occupation with the average age at death for all occupations discloses whether persons in that occupation are dying at unusually young or old ages. Does it follow, therefore, that the occupation is the cause of shortening or lengthening the lives of persons engaged in it? Not necessarily, because those occupations in which the average age at death is low may be occupations

in which the workers are largely young men. On the other hand, occupations in which the average age at death is high may be ones which attract or are possible only for older men.

Another statistical method which is very commonly used in studying occupational mortality is the "proportionate mortality" method. Thus, for example, to indicate the relation of occupation to tuberculosis, Dr. Hoffman of the Prudential Life Insurance Company has collected the data given in Table 51 from the statistics of the United States Registration Area for the years 1908 and 1909. The figures given here apply to all workers aged fifteen years and over.

TABLE 51

PROPORTIONATE MORTALITY FROM TUBERCULOSIS. UNITED STATES REGISTRATION AREA: 1908 AND 1909

Occupation.	Percentage of all deaths caused by tuberculosis.
All occupied males	14.9
Farmers, planters, and farm laborers	8.7
Workers exposed to metallic dust	21.0

At first glance the figures seem to show that "farmers, planters, and farm laborers" are persons engaged in an occupation which serves as a preventive or cure for tuberculosis, for only 8.7 per cent. of their deaths are due to tuberculosis as compared to 14.9 per cent. for all occupied males in the Registration Area. And in a similar manner it would appear that "workers exposed to metallic dust" suffer from tuberculosis one and one-half

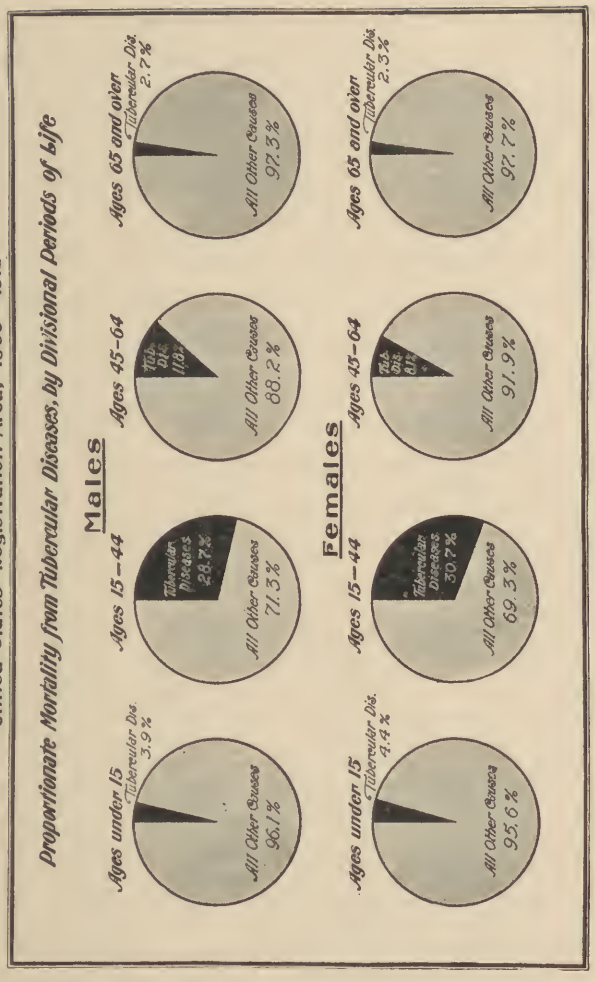


Fig. 22.—The mortality from tuberculosis at different age periods (reproduced by courtesy of the Prudential Insurance Company of America).

times as severely as do "all occupied males." It is always likely, however, when such proportionate mortality figures are used that the conclusions may be erroneous,

because a low tuberculosis proportionality may mean only that the deaths from other causes are unusually high, and the high tuberculosis ratio merely that the deaths from other causes are unusually low. This is always a shortcoming of "proportionate mortality" figures in studying occupational mortality.

This discussion has been presented not in an attempt to persuade the student of this problem that occupation does not affect the mortality—the health and welfare—of the worker, but merely to illustrate the pitfalls in the path of obtaining the statistical proof of such effects. Indeed, there cannot be much doubt that the effect of occupation is as important, as profound, in its influences upon longevity as it is insidious. Table 52 gives a set

TABLE 52

DEATH-RATES FROM PULMONARY TUBERCULOSIS. UNITED STATES REGISTRATION STATES, 1900

Occupation.	Deaths from pulmonary tuberculosis per 100,000 persons ten years of age and over.
Marble and stone cutters	540.5
Cigarmakers, tobacco workers	476.9
Compositors, printers, and pressmen	435.9
Servants	430.3
Bookkeepers, clerks, and copyists	398.0
Laborers (not agricultural)	370.7
All occupied males	**236.7**
Steam railroad employees	129.8
Clergymen	123.5
Miners and quarrymen	120.9
Farmers, planters, and farm laborers	111.7
Lumbermen and raftsmen	107.1
Bankers, brokers, and officials of companies	92.1

of figures of occupational death-rates from pulmonary tuberculosis for persons in the Registration States in 1900, which—although uncorrected for differences in the ages of the persons engaged in the different occupations—indicate what is in a measure the real relation between occupation and mortality.

In a recent study upon the incidence of tuberculosis among polishers and grinders in an axe factory (W. H. Drury) it was found that they showed a specific death-rate of 19 per 1000 population as compared with tuberculosis death-rates of 1.6 for other employees in the mills and 6.5 for the entire mill population. In Barre, Vermont, Dr. F. L. Hoffman found that granite cutters were dying at the rate of 20.11 per 1000 per annum, with a death-rate of 11.84 per 1000 from tuberculosis alone!

Illustrations of such comparisons of occupational mortality could very easily be multiplied. They would merely repeat the evidence that even in industries in which there are no specific poisonous hazards there are effects produced upon the workers which very profoundly alter, and generally shorten, their span of life. The rôle of dusts, overheating, excessive humidity, muscular fatigue, nervous strain, faulty or insufficient illumination, low wages, inadequate diet, and other factors would have to be studied—each alone and in combination with others—in order to determine how each occupation produces its effect upon the health and the welfare of the worker.

Seasonal Prevalence of Deaths.—All over the face of the earth climate, like time, affects the animate as well as the inanimate. Its influences are written as indelibly upon the races of mankind as upon the rocks, the soil, the plants, and animals. In the past it has played an important rôle, perhaps we may say the most important rôle, in the evolution of man, in the development of his body, of his surroundings, and of his social organizations. In the United States we know climate in all possible combinations of hot and cold, wet and dry, unsteady and changing, steady and unchanging. The mortality statistics show an unmistakable relation between death and climate. The relation varies in different parts of the country at the same time, because the climate for different places is different. But the sum of all climatic influences for the whole country still stands steadfast and the same, year after year. In Table 53 are listed the death-rates of the Registration Area for each month and for all months of the year 1919.

They show that the rates are highest in the winter months and lowest in the summer and early fall. They show regular, orderly changes from season to season, without sudden fluctuations. When we come to an analysis of the causes of death we shall find that there are differences in the seasonal prevalence of specific diseases and that some diseases prevail in those seasons in which others are rare. We shall find that some diseases which are with us the year round are more fatal in certain months than in others. The total effect of all these

TABLE 53

DEATH-RATES BY MONTHS, UNITED STATES REGISTRATION AREA, 1919

Month of year.	Death-rate per 1000.
January	1.7
February	1.3
March	1.3
April	1.1
May	1.0
June	0.9
July	0.9
August	0.9
September	0.9
October	0.9
November	0.9
December	1.0
All months	12.9
Average per month	1.1

variations is the monthly fluctuation in the death-rate which is shown in the table.

The significance of seasonal variations in deaths is too profound to be passed by without a few more words. To the physician and nurse, as well as to any other member of society who is interested in the health and well-being of his neighbors, the professional interest is direct. From January to April deaths are unusually frequent. The meaning of this statistical deduction, translated into nursing terms, is more sickness and more disablement and more social disruption demanding the adjusting care of the nurse. And the significance to nursing associations and welfare organizations is clear.[1]

[1] The student who is interested in reading some very illuminating discussions of the relation between man and climate will find the books by Professor Ellsworth Huntington, of Yale University (*Civilization and Climate*, 1915; *World Power and Evolution*, 1919, etc.), particularly interesting.

CHAPTER VIII

MORTALITY. THE CAUSES OF DEATH

In our younger days many of us learned a charming poem written by Oliver Wendell Holmes—The Deacon's Masterpiece; or, The Wonderful "One-hoss Shay"—which held an appeal for us because of its running rhyme and ready humor. It is probably not without justification, however, that to this poem is ascribed an interpretation more profound and more important than concerns merely its poetic qualities. How charming is the description of the deacon who built his masterpiece,

> ". . . the wonderful one-hoss shay,
> That was built in such a logical way
> It ran a hundred years to a day,"

for he had reasoned that shays break down, but never wear out. He had built it with each part as strong as the rest. And on the hundredth anniversary the parson was out for a drive when something happened:

> ". . . What do you think the parson found,
> When he got up and stared around?
> The poor old chaise in a heap or mound,
> As if it had been to the mill and ground!
> You see, of course, if you're not a dunce,
> How it went to pieces all at once—
> All at once, and nothing first—
> Just as bubbles do when they burst."

But when we consider that Holmes, besides having been a poet and a writer of keen, delighting essays, was also a physician and a surgeon and a professor of several branches of medicine in the Harvard Medical School, we can read a deeper meaning into "The One-hoss Shay." The deacon's shay, whose every part was as strong as every other and which went to pieces all at once, nothing first, may be symbolic of the perfect human body, and of the physician's ideal of death. The end should come not through sickness, not through accident, not through breakdown, but through normal wearing out and decay. And as bubbles do when they burst, our bodies should be perfect, whole and hearty until the final breath is drawn, whereupon they should dissolve into dust. How far the realization of this ideal is from the actual fact we all know only too well. What the causes are, the factors, which produce the premature breakdowns of parts of our bodies and premature death of the whole we shall learn as we analyze the statistics of deaths by their causes.

Classification of Causes of Death.—Before we can plunge into the statistical discussion we must again "refine and define." What is meant by "death" is clear enough, by "cause of death" is more obscure. In one list which I have available on my desk there are about 15,000 names of causes of death that are met with—many of them only rarely, it is true—on death certificates. Obviously a classification of these causes, to be

of any service, must be condensed to a convenient number. And in order that such classifications made in this country shall be comparable with similar classifications made abroad it is necessary that the abbreviated lists of causes of death shall be the same or similar, that each cause shall have as nearly as possible the same meaning the world over and shall include the same causes of the unabbreviated list. To meet these requirements representatives of the official statistical bureaus of many countries met in Paris in 1900, 1909, and in 1920 and drew up an "International List of Causes of Sickness and Death" following agreement upon certain rules of nomenclature and classification. The 1909 revision of the International List has been in use till very recently, and practically all of the standard statistics of death which are available today are based upon the use of the 189 titles in that list. The 1920 revised list contains 205 titles, several of which are causes of *sickness* only. The 1909 list included only causes of *death*. Although it is strongly recommended here that any persons who have occasion to classify deaths by causes shall utilize the 1920 International List, the 1909 list is described here because all of the statistics discussed in these chapters were classified before the 1920 revision was available.[1]

[1] The "Manual of the International List of Causes of Death," 1909, and the 1920 revision, can be obtained by writing to the Bureau of the Census, Department of Commerce, Washington, D. C. Nurses, field workers, and office employees who have occasion to work with causes of death will find the Physician's Pocket Reference to the In-

Fourteen Groups of Causes of Death.—The 189 causes of death were divided into fourteen groups in the following manner:

I. General diseases	1– 59
II. Diseases of the nervous system and of the organs of special sense	60– 76
III. Diseases of the circulatory system	77– 85
IV. Diseases of the respiratory system	86– 98
V. Diseases of the digestive system	99–118
VI. Non-venereal diseases of the genito-urinary system and annexa	119–133
VII. The puerperal state	134–141
VIII. Diseases of the skin and of the cellular tissue	142–145
IX. Diseases of the bones and of the organs of locomotion	146–149
X. Malformations	150
XI. Early infancy	151–153
XII. Old age	154
XIII. External causes	155–186
XIV. Ill-defined diseases	187–189

Primary and Secondary Causes of Death.—The standard certificate of death (see Fig. 18 in Chapter VII) calls for a statement of the "cause of death" (primary) and of the "contributory" cause of death. In the final classifications, unless otherwise stated, only the primary cause of death is used. When there are two or more

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ternational List of Causes of Death, obtainable from the Census Bureau upon request, a particularly convenient and valuable booklet to carry in a pocket. Physicians and public health nurses ought to own copies of this Pocket Reference and consult it each time they have occasion to describe a cause of death, just as they ought to use the International List, 1920 (also obtainable from the Census Bureau), every time they fill out in a report a cause of sickness.

causes of death, and if they are related, the *primary* cause is the one of longer duration. If the causes are entirely unrelated and if one is not the result or complication of the other, the most important cause and the one most commonly fatal is the *primary* one. The others are *secondary* (or *contributory*). (The inaccuracies and inconsistencies of "causes of death" which were mentioned in Chapter VII should be kept in mind throughout the discussion of mortality in these pages.)

Undesirable Terms.—Probably the greatest difficulty in the path of classification of causes of death is the use on certificates of non-specific terms. Such terms as "abscess," "accident," "injury," "atrophy," "weakness," "inanition," "illness," "congestion," "convulsions," "fever," "general decay," "heart disease," "inflammation," "surgical shock," "septicemia," "toxemia" are almost worthless for specific classification unless they are accompanied by further information. Persons who have occasion to specify a cause of sickness or a cause of death should realize the importance of accurate description. It is scarcely an overstatement of the case to emphasize that improvement in the accuracy with which causes of sickness and death are stated will do more to further the usefulness of vital statistics in public health work than almost any other statistical improvement. Physicians, registrars, and nurses, as well as statisticians, can play an important part in this contribution to public welfare.

When two or more causes of death operate simultaneously to cause death, and it is not easily evident which was the primary and which the secondary or contributory causes of death, certain standard procedures are used.[1] In the data discussed below—unless otherwise indicated—the statistics of death have been classified by these standard procedures.

Classifying Occupations.—When studying occupational statistics, as in these chapters, in respect to the relations between occupation and sickness or death, whenever possible occupations are classified according to the method of the United States Census Bureau.[2]

The person who contributes to the collection of occupational morbidity or mortality statistics should take great pains to distinguish between the *industry* and the *occupation* in which an individual is engaged. Two persons may be employed in an iron foundry, but one may be an office clerk and the other a tool grinder. Obviously, the hazards to which they are exposed will affect their health in a radically different manner. Even with respect to specific occupations it is important to describe the task in which an individual is engaged with the greatest possible or the most convenient accuracy. An employee working at the same occupation is exposed

[1] These are fully described and given in tabular lists in the Index of Joint Causes of Death, published by the Census Bureau.

[2] The Census Bureau publishes an Alphabetical Index to Occupations, 1920, and a Classified Index to Occupations, 1920, both of which are exceedingly valuable working guides.

to different dangers in an *iron* than in a *brass foundry*, in a *felt* hat than in a *straw* hat factory, in a *paper* box than in a *wooden* box factory. To obtain accurate occupation statistics it is as important to collect as to analyze them accurately.

The Principal Causes of Death.—The figures given in Table 54 are arranged to show the principal causes of death in the United States. The seven specific titles

TABLE 54

PROPORTIONATE MORTALITY FROM THE PRINCIPAL CAUSES OF DEATH. UNITED STATES REGISTRATION AREA, 1920

Rank.	Cause of death.	Percentage of all deaths.
	All causes	100.0
1.	Organic diseases of the heart	10.9
2.	Pneumonia (all forms)	10.6
3.	Tuberculosis (all forms)	8.7
4.	Acute nephritis and Bright's disease	6.8
5.	Cancer (all forms)	6.4
6.	Accidents	5.5
7.	Influenza	5.4
	All other causes	45.7

are listed in the order of their importance, organic diseases of the heart being placed at the head of the list because in 1920 it was the captain of the hosts of death. Influenza is at the foot of the list because—although it far surpasses in importance a great many other causes of death—it takes a smaller toll of human lives than any of the principal causes of death included in this list.

From these figures it appears that a half-dozen causes

of death—organic diseases of the heart, pneumonia, tuberculosis, acute nephritis, and Bright's disease, cancer and accidents accounted for approximately one-half of all the deaths which occurred in the United States Registration Area in 1920. The exact rank in order of importance of these most important causes of death is not always the same as in this list for 1920. It varies somewhat from year to year, it is different sometimes for males and females, for different parts of the country, and for different age groups in the population. For example, in 1919 tuberculosis was the cause of more deaths than pneumonia (9.8 per cent., as compared with 9.6 per cent.), although the relative importance of these two causes of death was reversed in 1920. Among infants, congenital debility, digestive disturbances, and respiratory diseases account for approximately three-quarters of all deaths. Among adults one of these three principal causes of infant deaths (congenital debility) is either of no or only of minor statistical importance. It will be of interest to notice that of the seven titles listed in Table 54, four we are accustomed to consider in a greater or lesser degree preventable causes of sickness and of death.

It is of significant importance that of the seven principal causes of death, two (pneumonia and influenza) run characteristically acute and brief courses before a fatal termination, in two more (accidents and tuberculosis) death may follow a short or long period of illness,

and in the remaining three (organic diseases of the heart, acute nephritis and Bright's disease, and cancer) the period of illness which may precede death from these causes generally does not come till late in adult life. These facts bear out the statement made in an earlier chapter that the principal causes of sickness are not the principal causes of death. Indeed, of the fifteen most frequent causes of disability listed in Fig. 16 of the discussion of morbidity (Chapter V) only one (influenza-grippe) appears as one of the most important causes of death.

The Trend of Mortality from the Principal Causes.—The trend of mortality from all causes of death combined has been nearly uniformly downward. This was brought out in an earlier paragraph when the declining annual death-rates were under discussion. A further analysis of the trend of mortality caused by the specific principal causes of death casts some light on the declining crude death-rate. In Table 55 (page 193) the specific death-rates from ten causes of death are given for the Registration Area for the years 1900, 1905, 1910, 1915, and 1920.

The first fact of note which appears from these figures is that the crude death-rate, taken by these five-year periods, shows a steady decline. Then it appears, if the specific death-rates are examined, that the causes of death fall into two groups—those with falling death-rates and those with stationary or increasing death-rates. In the former group we have typhoid fever,

TABLE 55

THE TREND OF MORTALITY FROM CERTAIN IMPORTANT CAUSES OF DEATH. UNITED STATES REGISTRATION AREA, 1900–1920

Cause of death.	Death-rate per 100,000 population: 1900.	1905.	1910.	1915.	1920.
All causes[1]	1755.0	1602.0	1495.8	1355.1	1306.0
Typhoid fever	39.9	27.8	23.5	12.4	7.8
Diphtheria and croup	43.3	23.6	21.4	15.7	15.3
Influenza	22.9	18.9	14.4	16.0	71.0
Tuberculosis (all forms)	201.9	192.3	160.3	146.4	114.2
Cancer (all forms)	63.0	71.4	76.2	81.4	83.4
Cerebral hemorrhage and apoplexy	67.5	71.6	73.7	79.6	80.9
Organic diseases of the heart	111.2	132.5	141.5	147.1	141.9
Pneumonia (all forms)	180.5	148.8	147.7	133.1	137.3
Diarrhea and enteritis (under two years)	108.8	97.0	100.8	59.8	44.0
Acute nephritis and Bright's disease	89.0	103.4	99.0	105.1	89.4

diphtheria and croup, tuberculosis, pneumonia and diarrhea, and enteritis—*i. e.*, all of the communicable diseases with the exception of influenza; and in the latter group influenza, cancer, cerebral hemorrhage and apoplexy, organic diseases of the heart, and acute nephritis and Bright's disease, (except influenza) the so-called "degenerative" diseases.

The Age Factor.—A discussion of the principal causes of death would be incomplete without a table of figures to show the incidence of deaths from each cause at different ages of life. Such data are presented in Table 56 (see page 194). (Also see Fig. 21.)

Even a hurried inspection of this table shows how

[1] Exclusive of still-births.

TABLE 56

MORTALITY FROM THE PRINCIPAL CAUSES OF DEATH AT ALL AGES OF LIFE[1]

Age period.	Death-rates per 100,000 persons, from— All causes.	Typhoid fever.	Diphtheria and croup.	Tuberculosis.	Pneumonia.	Diarrhea and enteritis.	Cancer.	Cerebral hemorrhage and apoplexy.	Organic diseases of the heart.	Acute nephritis and Bright's disease.
All ages (one and over)	1,181	16.8	24.3	185.7	77.5	26.3	70.0	68.1	140.1	96.8
1– 4	1,286	12.7	152.2	26.3	108.0	208.7	3.7	3.1	7.3	5.7
5– 9	366	12.9	66.1	16.2	19.7	8.8	1.4	.7	16.2	4.3
10–14	253	16.2	13.8	33.9	11.5	2.4	1.3	.8	26.7	4.9
15–19	439	24.6	3.0	150.5	20.8	1.9	2.8	1.6	30.2	8.6
20–24	643	23.4	1.6	273.4	29.5	2.8	4.1	2.9	30.6	15.3
25–34	867	18.5	1.3	330.1	50.1	4.5	15.7	8.9	53.5	36.3
35–44	1,283	15.1	.9	345.4	89.7	7.7	76.2	35.9	121.8	101.3
45–54	1,908	13.1	.8[2]	267.3	139.6	10.9	198.6	130.6	253.6	216.7
55–64	3,456	12.3	.....	221.1	247.9	28.2	382.5	359.0	604.8	453.3
65–74	7,253	11.8	.....	178.7	468.7	80.3	617.2	918.4	1523.1	970.6
75 and over	13,521	10.6	.....	156.1	791.3	182.5	818.2	1841.5	2808.1	1715.2

[1] The data in this table are taken from the Mortality Statistics of Insured Wage-earners and Their Families, by Dr. L. I. Dublin, and constitutes the experience of the Industrial Department of the Metropolitan Life Insurance Company for 1911–1916.

[2] This rate (0.8) is for ages forty-five *and over*.

markedly different are the age distributions of the deaths from these causes of death. For "all causes" the death-rate is very high in the earliest years, drops to a minimum in the ages ten to fourteen, and rises to the maximum at seventy-five years and over. Diarrhea and enteritis and pneumonia are the only important causes of death included in the table for which the death-rates show the same kind of distribution. The mortality from diphtheria and croup is highest in the ages one to four and declines at higher ages; from typhoid fever and tuberculosis the mortality is greatest in the young adult years; and mortality is greatest in the late adult years from the remaining causes—cancer, cerebral hemorrhage and apoplexy, organic diseases of the heart, and acute nephritis and Bright's disease.

Typhoid Fever.—The decline in the mortality from typhoid fever is one of the outstanding sources of gratification to public health workers. The application of sanitation to securing improvement in the conditions of living, in providing pure water-supplies, in isolating typhoid cases and carriers, and in the use of prophylactic vaccination has brought the typhoid death-rate down from about 40 per 100,000 in 1900 to less than 8 in 1920.

Fig. 23.—(Reproduced from the Condensed Annual Report, Department of Health, New York City, 1921.)

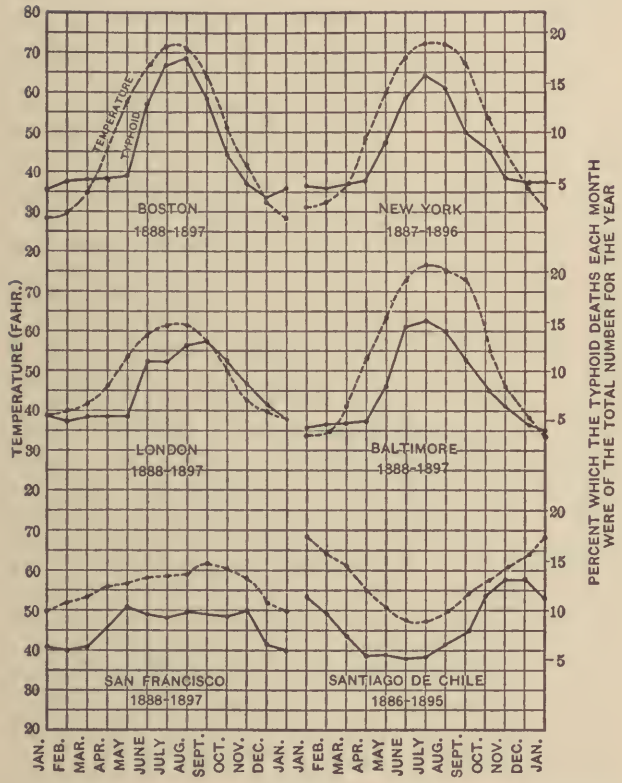

Fig. 24.—Diagram showing the relation between atmospheric temperature and seasonal distribution of typhoid fever (after Sedgwick and Winslow).

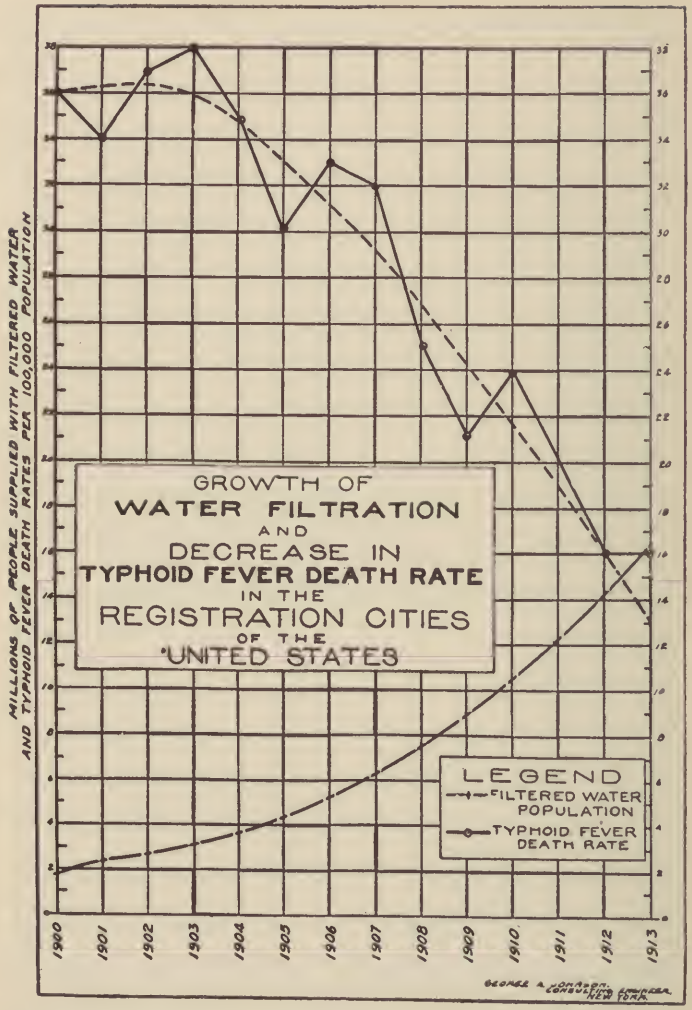

Fig. 25.—(Reproduced from "The Typhoid Toll," by George A. Johnson.)

Diphtheria and Croup.—The death-rate for diphtheria and croup has declined from over 43 per 100,000 in 1900 to about 15 per 100,000 in 1920. For a long time it was felt that the rate would show a continuous decline with the passage of time. Unfortunately this has not been entirely the case. As indicated in Table 55, the diphtheria death-rate had fallen to a reasonably low mark by 1910. Since then the rate has been maintained at the comparatively low level of less than 20, but has not been lowered very much below that point. The fact that diphtheria *morbidity* has not been decreasing appreciably for twenty or thirty years and that the *mortality* has become nearly stationary in recent years is a source of real concern to the public health world. The application of the Schick test to determine whether individuals are immune or susceptible to diphtheria infection and the utilization of toxin-antitoxin to immunize the susceptible ones may prove a boon in this field of disease and death prevention.

That diphtheria is essentially a disease of young children is illustrated by the data in Table 57.

TABLE 57

MORTALITY FROM DIPHTHERIA. UNITED STATES REGISTRATION AREA, 1910–1915

Years of life.	Death-rate per 100,000.
2d	151.0
3d	128.8
4th	112.2
5th	92.3
5th–9th	50.2
10th–14th	12.2

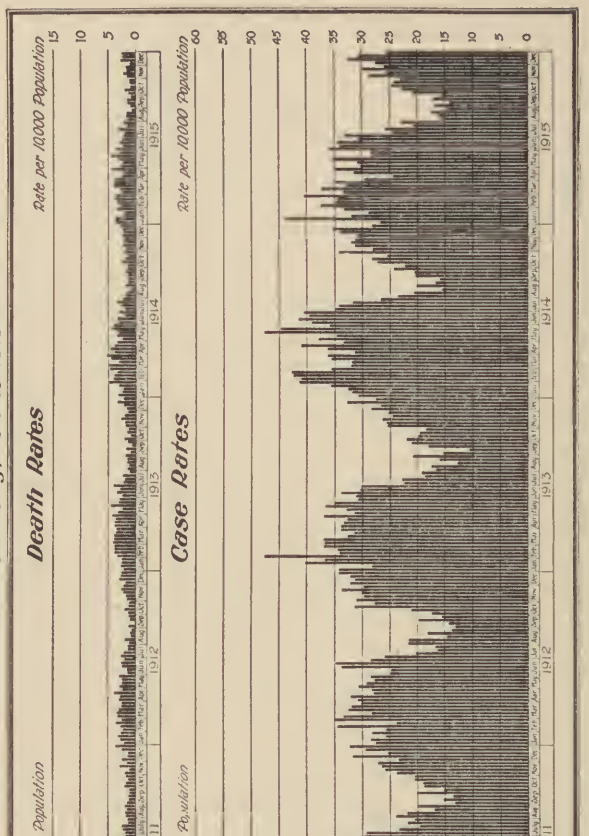

Fig. 26.—The seasonal distribution of diphtheria and croup and the relation between morbidity (case rates) and mortality (death-rates) (by courtesy of The Prudential Insurance Company of America).

Commonly diphtheria and croup play a negligible rôle in the first year of life (presumably as a result of a temporary immunity in the infant inherited from the

mother) and reach their maximum death-rates in the second year. Although the death-rate then declines in

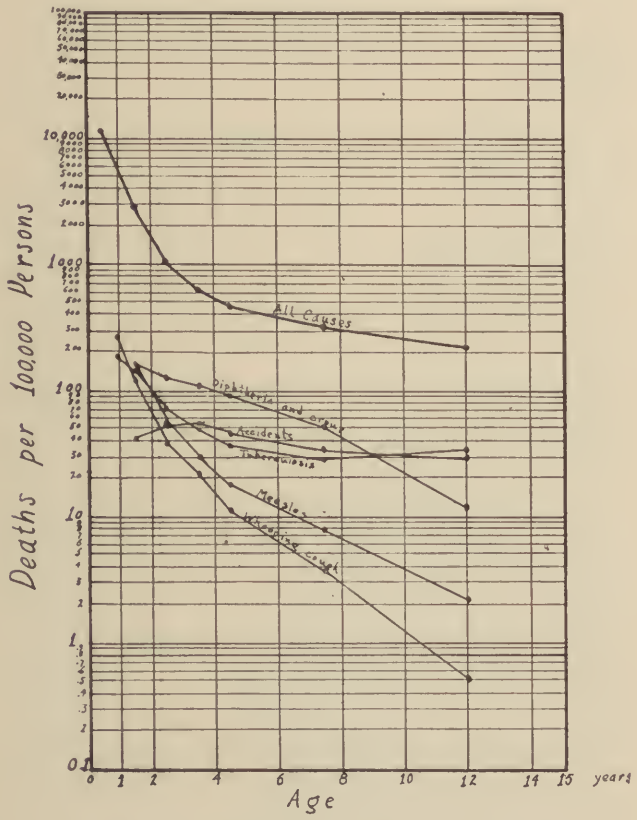

Fig. 27.—The mortality of childhood (Dublin).

the succeeding years of life, diphtheria and croup still remain, from the third to the tenth years, the most important cause of death. The rates are generally about

the same for males and for females, and higher for white than for colored persons. The incidence of mortality from certain other important causes which operate in the years of childhood are illustrated in Fig. 27.

Tuberculosis.—Of all the infectious diseases, tuberculosis is the commonest in occurrence and the most wide-spread. In the United States alone it is estimated that 160,000 persons die each year from this one disease. And in certain other countries, for example, in Germany, the proportionate mortality is even higher. Of the 110,000,000 people living in this country today, it is estimated that nearly 10,000,000 are doomed to die from the dreaded "White Plague" unless its onslaught is checked. When this appalling loss is considered along with the facts that tuberculosis falls during the period of life of greatest usefulness—75 per cent. of the deaths occurring between the ages of fifteen and sixty—and when death brings the greatest burdens upon the families of the deceased, the tremendous importance of all antituberculosis measures and campaigns can be fully recognized.

The Course of Mortality from Tuberculosis.—If space were available here figures could be presented to show that tuberculosis began to decline before the nature of the infection was known. The decline has been gradual. Modern methods have so far made little apparent impression upon the gross amount of the infection. The social and economic conditions of the mass of the pop-

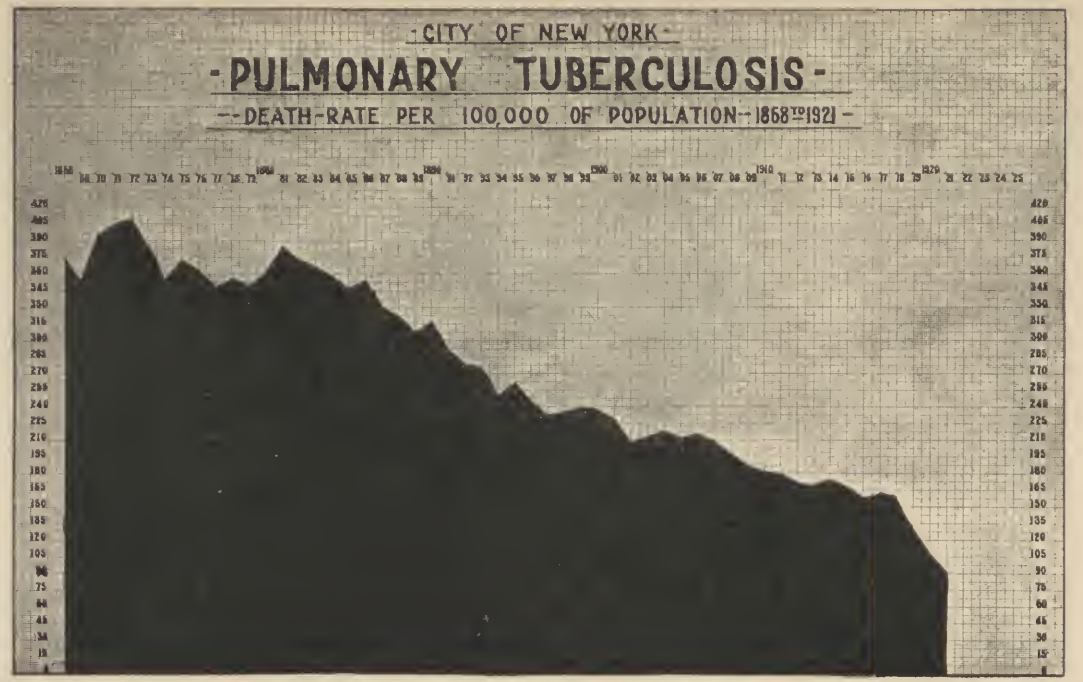

Fig. 28.—The declining mortality from pulmonary tuberculosis in New York City, 1868–1921 (reproduced from the Condensed Annual Report, Department of Health, New York City, 1921).

ulation must be improved before very great decline in the mortality rate can be expected.

The decline in the mortality from tuberculosis in the

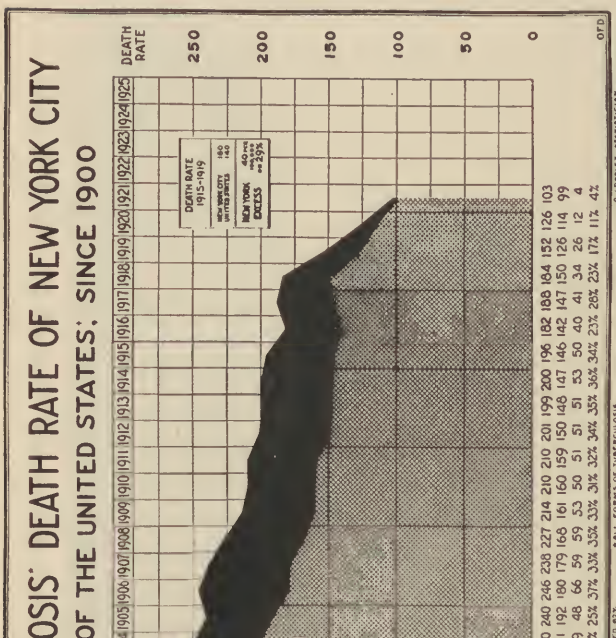

Fig. 29.—Comparison of the declining mortality from tuberculosis in New York City and in the Registration Area of the United States (reproduced by courtesy of Mr. G. J. Drolet).

last two decades has already been indicated in Table 55 (p. 193). There was a slight rise in the death-rate for tuberculosis for 1918. This has been considered by some

as due to certain postwar conditions and to the influenza-pneumonia epidemic. Explanations for the exceedingly low death-rates which prevailed in 1919 and 1920 are similarly problematic. They were probably due, in a large part at least, to the extraordinary prosperity and good economic condition of the great mass of the working class—the class which ordinarily suffers most severely from tuberculosis. (See pages 176-181 for a discussion of occupation and tuberculosis morbidity and mortality.)

Forms of Tuberculosis.—The figures given up to this point all refer to all forms of tuberculosis. Of these, tuberculosis of the lungs (pulmonary tuberculosis, consumption) is by far the most important. One must not lose sight of the fact that several of the other types of tuberculosis are very commonly met with and are of very considerable importance. The following set of figures is taken from the experience of the Metro-

TABLE 58

THE MORTALITY FROM DIFFERENT FORMS OF TUBERCULOSIS. EXPERIENCE OF METROPOLITAN LIFE INSURANCE COMPANY, INDUSTRIAL DEPARTMENT, 1911–1916

Forms of tuberculosis.	Percentage of total.	Death-rate per 100,000 persons.
Tuberculosis (all forms)	100.0	205.1
Tuberculosis of the lungs	84.7	173.9
Acute miliary tuberculosis	5.8	11.9
Tuberculous meningitis	4.2	8.6
Abdominal tuberculosis	2.9	5.9
Pott's disease	0.8	1.6
White swellings	0.5	1.1
Tuberculosis of other organs	0.9	1.8
Disseminated tuberculosis	0.2	0.5

politan Life Insurance Company, Industrial Department, for the years 1911–1916, and represent a study of over 110,000 deaths from all forms of tuberculosis.

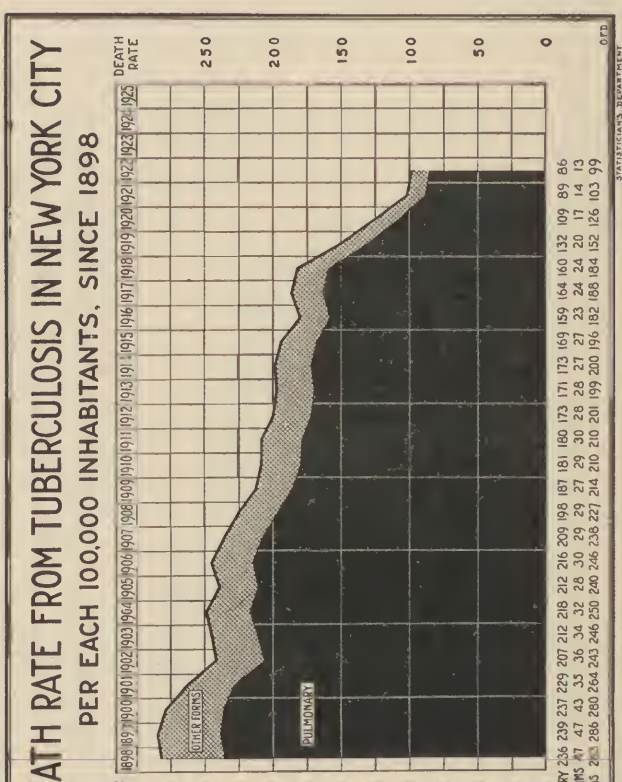

Fig. 30.—The declining mortality from tuberculosis ("Pulmonary" and "Other Forms"), New York City, 1898–1922. (by courtesy of Mr. G. J. Drolet).

They show that acute miliary tuberculosis, tuberculous meningitis, and abdominal tuberculosis cause large numbers of deaths, and have death-rates of approxi-

mately the same magnitude as diphtheria, croup, and typhoid fever.

The Age at Death from Tuberculosis.—Certain striking facts about the incidence of tuberculosis by age are given in Table 56. Data which we have not space to reproduce here show that the mortality from tuberculosis is about twice as high among colored as among white persons; that for whites as well as for colored the mortality is greater among males than among females; and that the rates for each sex vary with age. In the first five years of life there is a comparatively high rate. This drops to a minimum in the age period five to nine years, increases a little in the period ten to fourteen years, and mounts continuously till the maximum rates are reached in young adult males thirty-five to forty-four years of age, and somewhat earlier in females. The rates for each sex then decline with advancing age.

Tuberculosis and the Race Factor.—A table of death-rates by color, sex, and age could easily be prepared for the United States Registration Area, instead of for the occupied population insured in the Metropolitan Life Insurance Company, as in Table 56. The rates for the latter group are higher, of course, than the corresponding rates for the general population, because of occupational hazards, lower social and economic levels, racial factors, etc., which are contributory influences of greater magnitude in tuberculosis than in any other of the chief causes of death, but they more accurately describe the

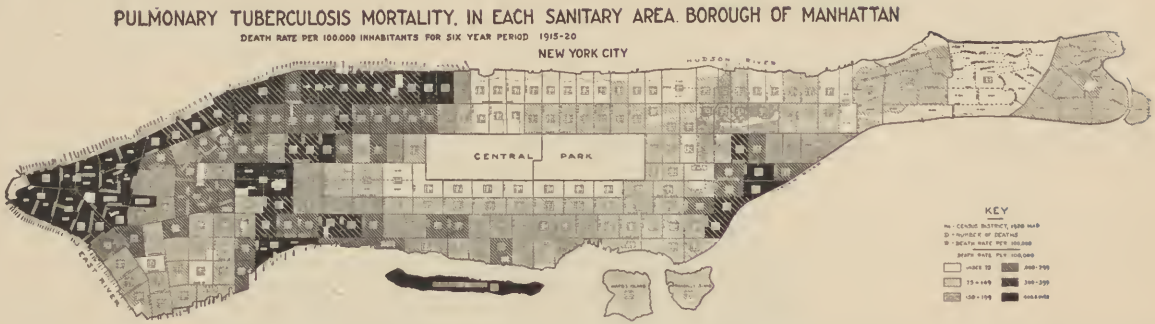

Fig. 31.—(Compiled from Reports, New York City Department of Health, and New York City 1920 Census Committee. Reproduced by courtesy of Mr. G. J. Drolet, Statistician, Research Service, New York Tuberculosis Association.)

tuberculosis mortality in the population groups with which public health nurses, for example, have contact. Tuberculosis was once the unrivalled "White Plague." Today it has been superseded as the leading cause of death among *white* persons in the United States by organic diseases of the heart and pneumonia. It is probably as true now as it was in 1910 that tuberculosis and syphilis are the greatest enemies of the *negroes* in this country.

Tuberculosis and Nationality.—The variations in tuberculosis incidence for people of different nationalities are indicated by the following table (Table 59), obtained from data contained in the report of Dr. Dublin's study of the mortality of different race stocks living side by side in New York State in 1910.

TABLE 59

RELATION BETWEEN NATIVITY AND MORTALITY FROM TUBERCULOSIS OF THE LUNGS, NEW YORK STATE, 1910

Nativity.	Death-rate per 100,000 persons: Males.	Females.
Native born	170.9	109.6
Born in Ireland	589.3	276.1
Born in Germany	267.4	115.3
Born in England, Scotland, and Wales	215.2	123.3
Born in Austria-Hungary	166.0	102.6
Born in Italy	112.1	160.1
Born in Russia	114.7	74.6

From the facts indicated by these figures and from others Dr. Dublin has drawn the following conclusions:

"The lowest mortality rate in the population of New York State is found among the native born of native

parentage. This is true for both sexes and for virtually every age period, but is marked at the adult ages. The foreign born and their native-born offspring agree much more closely with each other than they do with the native-born of native parentage. There are marked variations, to be sure, in the several age periods and in the two sexes, but the first generation Americans and the foreign stock from which they have arisen show unmistakably their close connection. The death-rates of the component races among the foreign born present very marked variations. Remarkably low rates are found among the Russians, and this is largely accounted for by the presence of a large proportion of Jews among them. The Italians follow very closely with exceptionally low rates of mortality, although Italian females at certain age periods show rather unfavorable conditions, especially from the respiratory diseases. The remaining races may be arranged roughly in the following increasing order of mortality: Austro-Hungarians, British, Germans, and Irish. Of these four nationalities, the first appears to be the only one whose mortality in New York State is more favorable than that prevailing in the native country. The very high rate of mortality among the Germans and especially among the Irish is one of the surprising facts of this study. Apparently it is the very high incidence of pulmonary tuberculosis that is largely responsible for this condition, although the degenerative diseases also present rates much in excess of those for the native born of native parentage or for the same nationalities abroad. These facts are clearly indicative of unfavorable conditions of life and work among the peoples in question, and point definitely to the need of special public health work by the state and various city departments of health for these groups of the population. A large number of unnecessary deaths would readily be prevented by a concerted effort carried over a period of years."

In a recent study it was indicated that if tuberculosis were eradicated, other things remaining unchanged, two and one-half years would be added to the expectation of life of each individual twenty years of age!

The Costs of Tuberculosis.—The recent careful estimates of the costs of sickness and death from tuberculosis and the costs of prevention prepared by Dr. Haven Emerson prompt the following quotation as an indication of certain facts pertinent to this discussion and as an excellent illustration of how such estimates are obtained. (This is taken from a paper prepared at the request of the Association for Improving the Condition of the Poor, New York City, to persuade certain persons that investment in prevention of tuberculosis would be a profitable undertaking. The data were prepared to illustrate the costs involved in a five-year antituberculosis program.)

INVESTMENT IN ADEQUATE PREVENTION

1. Population:
   - United States 108,500,000
   - New York City ..... 5,850,000 January 1, 1922
   - Test area 500,000
2. Expected death-rate from all forms of tuberculosis:
   - United States
   - New York City ..... 90 per 100,000 1922
   - Test area
3. Lives expected to be lost in 1922 from all forms of tuberculosis:
   - United States 97,650
   - New York City 5,265
   - Test area 450

4. Estimate of 7 active cases of tuberculosis, all forms, per death from all forms of tuberculosis in 1922:

United States	683,550
New York City	36,855
Test area	3,150

5. Two and one-third years of sickness care needed per each death per annum from all forms of tuberculosis:

United States	253,167
New York City	13,650
Test area	1,167

6. Estimated cost of deaths from tuberculosis for entire life span of the entire population:

United States. (Population × $250)	$27,125,000,000
New York City	1,462,500,000
Test area	125,000,000

7. Estimated cost of tuberculosis deaths (all forms) for one year of life of those now living:

United States	$521,634,515.38	Or at the rate of
New York City	28,125,000.00	$4.81 per capita
Test area	2,403,846.92	of population.

8. Estimated cost of sickness; total deaths × 7/3 × $1500:

United States	$341,775,000	Or at the rate of
New York City	18,427,500	$3.15 per capita of
Test area	1,575,000	population.

9. Combined estimated cost of deaths and sickness:

United States	$863,409,615	Or at the rate of
New York City	46,552,500	$7.96 per capita.
Test area	3,978,847	

10. Estimated per capita loss of all tuberculosis patients annually from all forms of tuberculosis:

United States New York City Test area	$1262.00

11. Cost of $3.00 per capita of population per annum for ideal practicable program for prevention of tuberculosis:

United States	$325,500,000
New York City	17,550,000
Test area	1,500,000

12. Estimated savings as result of 50 per cent. reduction in tuberculosis deaths in 1926:

United States ($\frac{1}{2}$ death loss + $\frac{1}{2}$ sickness cost)	$431,704,807.50	Or $3.98 per
New York City	23,276,250.00	capita.
Test area	1,989,423.50	

13. Proposed cost of preventive service 1922–1926.. $3.00 per capita.
Proposed cost of preventive service 1927..... 2.75 per capita.

14. Estimated losses which will be incurred on basis of 1921 experience from all forms of tuberculosis per capita of population in 1922, $7.96; in 1927, $3.98.

Influenza and Pneumonia.—It is commonly stated in medical literature that no one ever dies from influenza *per se*. The death-rate from influenza-pneumonia is ordinarily between 15 and 25 per 100,000 persons. Then comes an epidemic or a pandemic and the rate shoots up sky-high (the rate was 298.9 per 100,000 in 1918!) The death-rate for bronchopneumonia and lobar pneumonia (non-influenzal) has, on the whole, been declining. The decline has not been as rapid in the last ten years as epidemiologists had anticipated. The improvements in clinical knowledge, in immune sera and in the isolation of pneumonia patients will probably bring a greater reduction in the pneumonia death-rate in the next decade than the present pessimistic attitude toward the control of this disease indicates.

Diarrhea and Enteritis.—The vital statistics of diarrhea and enteritis (under two years) as a cause of death were discussed in Chapter IV.

The Communicable Diseases of Childhood.—These have already received comment in the discussion of the specific causes of sickness and death. The magnitude

of the death-rates and their relation to age can be taken in at a glance by reference to Fig. 27.

The Diseases of Adult Life.—The remaining causes of death listed in Table 55—cancer, cerebral hemorrhage and apoplexy, organic diseases of the heart and acute nephritis, and Bright's disease—may all be considered in a group. If space were available it could be shown in greater detail than Table 56 shows that all of these causes of death operate with greatest severity among persons forty-five years of age and older. (Organic diseases of the heart and acute nephritis and Bright's disease also cause appreciable mortality among younger persons.) It is customary to speak of this whole group of causes of death as the "degenerative diseases," presumably because they become of leading importance in those years of life when the human body is supposed to "degenerate," and because, many people hold, they are the result of the "degenerative" effect of "fast" or "hard" living.

One of the notable contributions of vital statisticians in the few years immediately succeeding the decade 1900–1910 was the proof that in the United States the specific death-rates for ages under forty-five were either stationary or increasing, in spite of a decreasing crude death-rate for all ages. This is clearly illustrated in Table 60, taken from a paper on this subject by Dr. L. I. Dublin.

In the intercensus period 1910–1920 studies of the mortalities of special groups in the population appeared

TABLE 60

COMPARISON OF MORTALITY OF MALES AND FEMALES BY AGE GROUPS. DEATH-RATE PER 1000 POPULATION IN 1900 AND 1911

(Registration States as Constituted in 1900)

Age.	Males. 1900.	Males. 1911.	Males. Percentage increase or decrease.	Females. 1900.	Females. 1911.	Females. Percentage increase or decrease.
Under 5 years	54.2	39.8	−26.57	45.8	33.3	−27.29
5– 9 years	4.7	3.4	−27.66	4.6	3.1	−32.61
10–14 "	2.9	2.4	−17.24	3.1	2.1	−32.26
15–19 "	4.9	3.7	−24.49	4.8	3.3	−31.25
20–24 "	7.0	5.3	−24.29	6.7	4.7	−29.85
25–34 "	8.3	6.7	−19.28	8.2	6.0	−26.83
35–44 "	10.8	10.4	− 3.70	9.8	8.3	−15.31
45–54 "	15.8	16.1	+ 1.90	14.2	12.9	− 9.15
55–64 "	28.9	30.9	+ 6.92	25.8	26.0	+ 0.78
65–74 "	59.6	61.6	+ 3.36	53.8	55.1	+ 2.42
75 and over	146.1	147.4	+ 0.89	139.5	139.2	− 0.22
All ages	17.6	15.8	−10.23	16.5	14.0	−15.15

to indicate a state of affairs similar to that of the first decade of the century. The feeling among statisticians has been one of watchful waiting for the appearance of the 1920 Census data on the age distribution of the population. Without these figures even reasonably accurate measurements of the trend of mortality in the whole country were impossible. Enough of this data has already been published from the Census Bureau and from reliable statistical offices dealing with smaller population groups to indicate beyond doubt that in 1920 the death-rate was probably lower in every age group than in 1910.

In the *Public Health Reports* for March 3, 1922 (Vol. 37, No. 19, pages 487–489), the Department of Com-

merce, through the Bureau of the Census, issued a statement under the title "Death-rate in Every Age Group Lower in 1920 than in 1910." Since then more detailed data have been published and the trend of the age-specific death-rates and of the expectation of life at each age have been made known. These are clearly illustrated in Table 61, which applies in each of the years (1901, 1910, and 1920) to the same states.

TABLE 61

DEATH-RATES PER 1000 AND COMPLETE EXPECTATION OF LIFE. ORIGINAL REGISTRATION STATES, 1901, 1910, AND 1920

	1901[1]		1910[1]		1920[1]	
Age.	Death-rate per 1000.	Complete expectation of life.	Death-rate per 1000.	Complete expectation of life.	Death-rate per 1000.	Complete expectation of life.
0	124.48	49.24	114.62	51.49	90.11	54.29
5	6.05	54.98	4.66	56.21	4.43	57.19
10	2.67	51.14	2.27	52.15	2.12	53.06
15	3.47	46.81	2.84	47.73	3.13	48.66
20	5.89	42.79	4.68	43.53	4.68	44.54
30	7.97	35.51	6.51	35.70	6.55	36.80
40	10.10	28.34	9.39	28.20	7.94	29.14
50	14.59	21.26	14.37	20.98	12.76	21.54
60	27.02	14.76	28.58	14.42	25.66	14.69
70	56.41	9.30	59.52	9.11	59.48	9.13
80	127.23	5.30	130.28	5.25	128.88	5.32
90	252.95	2.95	249.62	3.03	247.63	3.02
100	453.73	1.58	401.91	1.85	398.70	1.87

It is to be noted that both Tables 60 and 61 apply to the original registration states. It is therefore pertinent

[1] The tables for 1901 and 1910 were copied from the *United States Life Tables*. The table for 1920 was constructed by the Statistical Bureau of the Metropolitan Life Insurance Company from advance data on population and deaths supplied by the Bureau of the Census.

TABLE 62

DEATH-RATES IN THE REGISTRATION AREA, 1910 AND 1920

Age.	Death-rates per 1000 population: 1910.	1920.	Percentage decrease.
All ages	15.0	13.1	12.7
Under 1 year	130.8	96.6	26.1
1–14 years	63.6	48.0	24.5
15–44 "	69.1	65.9	4.6
45–74 "	25.8	22.8	11.6
1–74 "	10.5	9.4	10.5
75 and over	143.6	134.9	6.1

to include Table 62 which gives the corresponding data for the expanding United States Registration Area.

In Tables 61 and 62 it appears clearly that the death-rates were lower in 1920 than in 1910. Correspondingly, of course, the expectation of living has increased proportionately at each age of life up to age eighty, beyond which no significant change is evident.

Table 55 (p. 193) shows that the death-rates for 1920 were lower than those for 1910, not only for all causes of death but also for each of the principal causes of death—*i. e.*, tuberculosis (all forms), pneumonia (all forms), acute nephritis and Bright's disease, accidents, typhoid fever and "all other causes," except influenza, cancer (all forms), and puerperal causes (total). Puerperal septicemia showed a decrease. Organic diseases of the heart showed practically no change (an increase from 141.5 in 1910 to 141.9 in 1920). These facts are presented in a more concise form in Table 63 (p. 218).

The question has been raised whether the death-rates

TABLE 63

MORTALITY FROM PRINCIPAL CAUSES OF DEATH, UNITED STATES REGISTRATION AREA, 1910 AND 1920

Cause of death.	1910.	1920.	Percentage decrease in the death-rate. 1910–1920.
All causes	1496.2	1306.0	12.7
Organic diseases of the heart	141.5	141.9	−0.3[1]
Pneumonia (all forms)	147.7	137.3	7.0
Tuberculosis (all forms)	160.3	114.2	28.8
Acute nephritis and Bright's disease	99.1	89.4	9.8
Cancer (all forms)	76.2	83.4	−9.4
Accidents	84.4	71.4	15.4
Influenza	14.4	71.0	−393.1
Puerperal causes (total)	15.7	19.2	−22.3
Puerperal septicemia	7.2	6.6	8.3
Typhoid fever	23.5	7.8	66.8
All other causes	726.0	563.9	22.3

for 1920 are not unusually low and really do not indicate the true trend of mortality at the higher ages of life. There is not enough new data available at this time to cast any significant light upon the problem.

Whether the principal causes of death in adult life are or are not "degenerative" diseases, these figures indicate that the mortality caused by them is probably declining. There may have been—there probably occurred—an increase in the death-rates for these diseases in the period 1900–1910. It appears today that a turning-point has been reached and that mortality is declining in every period of life.

[1] A *minus sign* (−) preceding a number means an *increase* instead of a decrease in the death-rate.

CHAPTER IX

THE INTERPRETATION OF STATISTICS. STATISTICAL ERRORS AND FALLACIES

In the preceding chapters we have repeatedly taken occasion to indicate certain inaccuracies or shortcomings of the statistical data and throughout have emphasized how important it is even for the most accomplished statistician to handle statistics with discretion and care. We are more directly concerned in these pages with the untrained statistician, with the person whose professional duties are in a greater measure non-statistical, but who can use to advantage the methods and knowledge of vital statistics in studying a problem or in measuring results. The physician, the association director, or the nurse cannot be, except rarely, a mathematician or a statistician. None the less he and she may easily learn to know enough about mathematics and statistics to understand their use in the simpler problems of professional life. They may learn to comprehend the accuracies and inaccuracies of their data and to evaluate these in the interpretation of their findings.

Four Rules in Statistical Work.—The great French scientist, Quetelet, laid down four rules to follow in statistical work:

1. Never have preconceived ideas as to what the figures are to prove.

2. In a statistical study never reject a number merely because it varies considerably from the average or because it appears to contradict what you expect.

3. Try to weigh and record *all* the possible causes of an event, and do not attribute to one what is really the result of the combination of several.

4. Never compare data which have nothing in common.

"Were these rules constantly followed, the science of statistics would be much more respected than it is, and the value of its results would be greatly increased" (Newsholme). Certainly we would not hear people say "You might as well compare your figures with the price of beans in Boston."

Three Kinds of Errors in Vital Statistics.—The errors and fallacies that are common in conclusions which are derived from statistical work are generally due to three kinds of mistakes:

1. Working with incomplete or inaccurate data.

2. Inaccurate arithmetic or copying of data, or other errors of analysis.

3. Unsound interpretations of statistical results.

In this short chapter it is possible merely to outline these sources of difficulty and to indicate by brief discussion of typical illustrations the principles of accurate statistical compilation, analysis, and interpretation.

Completeness of the Data.—Statistics are merely statements of facts in numerical terms. Numbers are not statistics unless they describe facts, and there is no golden rule by which one may know whether they do or do not describe facts. One must know who obtained the statistics, how, where, and when they were obtained, and to how much "editing" or "correcting" they have been subjected. The obtainance of this knowledge is the starting-point in a statistical study. When working with the statistics of a census, for example, it is essential to know the conditions under which the enumeration was made. In a national census the whole population is canvassed, and hence the findings are generally descriptive of a whole community, of a complete population. A local or a special census—for example, a social or religious survey of a particular locality—may cover only a selected part of a population, only socially and economically poor or only well-to-do persons, or only native-born or foreign-born persons, or only persons from one foreign country or employed in special industries and engaged in restricted occupations. It may have been made by more or by less carefully trained enumerators than are employed in the national census. Obviously the statistical findings in the latter may not be comparable with those of the former. Comparability of statistics has been called a will-o'-the-wisp, and with some justice. If due precautions are taken, however, it is not impossible of attainment.

Accuracy of the Data.—To get *accurate* data is sometimes very difficult. Each individual problem must be studied carefully and methods appropriate to it employed. Similarly, there is no rule of thumb to follow in determining how fully or completely a statistical tabulation must be to be available for accurate study. The United States Census Bureau must complete a canvass of more than 100,000,000 persons in less than thirty days. The care with which the work can be done on this scale and within that time is obviously limited. It must, therefore, be understood that the findings of the United States Census are not absolutely true—they are merely approximations of the truth with a degree of accuracy proportionate to the limitations under which the work was done.

Representative Statistical Samples.—Because an attempt is made to include all persons, the results of the national census may be expected, allowing for the partial inaccuracy of the statistics, to be typical of any *random sample* of the population. They cannot be expected to compare closely with results obtained from *selected* groups in the population. Indeed, here, as in any instances when dealing with statistics of *parts* of a population or of a group, the starting-point in the study should be a determination whether the part or group which is being studied has been taken at random from the whole population, whether it is typical of and similar to the whole population, or whether it is selective and different in

any respects from the average of the whole population. If the sample is random and not selective—if it includes persons of all the usual nationalities, of both sexes, all ages, engaged in various occupations, etc.—it may be taken as a typical population. Too commonly, however, studies are made upon selected groups, and the results are interpreted as though they applied to typical portions of the general population. A simple illustration of how this source of error operates may be given here.

A physician or an administrative officer of a hospital or nursing organization analyses his typhoid cases, as to fatality or lethality. He declares that 1 case in each 10 dies—hence a fatality rate of 10 per 100. He is, so far, on safe, descriptive grounds. But sometimes the author himself and more frequently readers and text-book writers do not recognize that in this particular study—if it were a hospital study, for example—the mild cases, the afebrile cases, have been missed, and that the fatality rate of 10 per cent. should be considered as restricted and applicable to *hospital* cases and not necessarily applicable to general typhoid experience. In attempting to make a general broad deduction—that is, to enter into the field of deductive statistics—a primary precaution is overlooked. The data from which the deduction is made is not typical of the group which it pretends to represent—it is not a *random* sample of all typhoid cases. That this one error in the matter of fatality in typhoid is not an uncommon one is evidenced

by the fact that the 10 per cent. fatality rate has been written into many text-books and is utilized by many workers in preventive medicine in calculating that there are 10 cases of typhoid fever in a community for each reported death from this cause. Yet in a recent typhoid outbreak the fatality was 6 per cent. (Hopewell, Va.) and in another (Salem, Ohio) the mortality was less than 2 per cent. of the cases. Is the mortality greater in endemic than in epidemic typhoid fever? Perhaps it is, but it is not known to be so, and until accurate evidence on this point is forthcoming it would be more reasonable to specify that a certain typhoid fatality (x) applies to certain types of cases.

Size of the Statistical Sample.—It is a safe general rule to collect statistics upon as large a group and for as long a period as is possible or convenient. The relation between the size of the statistical group and the accuracy of the results which may be obtained from the analysis will be discussed again below. To illustrate the type of error which may result from an insufficient sample we may comment upon a recent report in a reputable journal which described how a physician inoculated intravenously into 2 children the washings from the nasopharynx and a little blood from a child sick with measles. Neither of the inoculated children came down with measles. Hence, the author reasoned, the etiologic agent for measles is not contained in the nasopharynx—not "in the nasopharyngeal washings," mind

you—nor in the blood of the sick child. Regardless of whether his materials were taken at the correct point in the course of the measles case, regardless of the faultlessness of his technic, regardless of the question of dosages used, it is a fact that children vary enormously in their natural or acquired immunity to measles, and it is distinctly possible that both of the subjects of this experimenter may have chanced to be immunes. Had the author inoculated 200 or 1000 children his case might have been worthy of consideration. Of course, a statistical group of 2 is extremely small, but the case illustrates why random and sufficiently large samples are absolutely essential prerequisites in statistical work.

Errors of Arithmetic.—Of errors which creep into statistical work through inaccuracies in the mathematical part not much can be said here. The arithmetic of descriptive statistics is simple and merely requires care and patience for the attainment of accuracy. Data which must be copied occasionally or repeatedly, or added, subtracted, multiplied, and divided, should be checked and repeated over and over again. It is generally advisable to do as much as possible of this work on mechanical devices. When the form sheets for statistical collections are being prepared it is wise to plan them so that sums must check in two or more items of each table. In addition, it is apropos merely to repeat the usual warning that all persons who are not specially trained in the higher branches of mathematics

will generally do the wiser thing by restricting their statistical analyses to simple arithmetical processes. This word of caution should not discourage the aspiring statistician who has merely a grounding in the elements of mathematics. It is meant merely as a word of advice that here, as elsewhere, discretion is the better part of valor. The calculation of such statistical derivatives as coefficients of variation, of correlation, etc., are better left to those persons who understand the mathematics upon which they are conceived. They are not essential except in certain special types of statistical studies. And even the ablest statisticians occasionally make errors with as well as without complicated mathematical analysis.

Errors of Interpretation.—Errors of interpretation are so common and their avoidance so important that they will be discussed in some detail. Assuming that "sampling" has been done accurately, that the sample is a random one and is sufficiently large, and that the statistical "analysis" has been carried out with faultless technic, perhaps the most common error of interpretation is that of reasoning *pros hoc, ergo propter hoc* (as the phrase has it)—that because two things go together statistically there is a causative or direct relation between them. This fallacy is such a common one in statistics or, for that matter, any other branch of science that it may better be termed an "indulgence" rather than an error. Instances in which it has appeared can

easily be given in the dozens. For example, when we were discussing the mortality from tuberculosis, we pointed out that the declining death-rate from this cause was not *necessarily* attributable to the antituberculosis campaign, although the latter had been growing regularly in the same period in which the former had been declining with similar regularity. As another example, it may be recalled that many years before the true cause of communicable diseases was understood it was shown that the incidence of certain of these diseases fluctuated in certain places in a similar manner as the level of the subsurface ground water. Disease and ground-water level went in parallel. It was therefore argued that there is a direct relation between the two. Today we have reason to doubt the accuracy of this deduction.

Another pertinent illustration of this same fallacy is given by Dr. Vaughan in the following anecdote:

"In 1888, at an international medical congress, I ventured to offer a paper in which I suggested that the summer diarrheas of infancy might be due to poisonous milk. When the paper was opened for discussion a learned, elderly man arose, and, after making some feeble, complimentary remarks directed to the writer, proceeded to demolish all his claims, and finally he suggested that the high infantile mortality, which was becoming greater and greater every year, could be attributed to the more common use of the baby perambulator because, he said, and no one could deny the statement, that the death-rate among children in this country had increased since the baby cab had come into

use. When I arose to close the discussion I said that I would withdraw all that I had claimed concerning poisonous milk, that the argument adduced by my critic could not be contradicted, but I would suggest that the high infantile mortality was due to the fact that we were more in the habit of carrying umbrellas than our ancestors, or that possibly it might be due to the fact that we eat more tomatoes than our grandfathers did."

One of the most illuminating illustrations of fallacious reasoning *pros hoc, ergo propter hoc* which has come to our attention is quoted from Professor Raymond Pearl. It compels us to question more closely many of the concepts which we hold and which, we believe, are based upon indubitable evidence:

"In 1881, before the diphtheria bacillus had been discovered, there appeared in one of the leading medical journals of Germany, by an author of standing, a paper apparently proving, or at least making apparently highly probable the conclusion that the eating of potatoes was the cause of diphtheria! It was shown, by conventional statistical reasoning, that the disease diphtheria first appeared in Europe near the close of the sixteenth century; that it appeared *after* potatoes were introduced as an article of diet; that the disease had increased concomitantly with, and at about the same rate as the increase in the consumption of potatoes as food; that the most severe epidemics of diphtheria occurred at the time of the planting and the harvesting of potatoes; children from two to three years of age were particularly attacked because they played with the potatoes at the time of sowing and harvesting, while the older children were in schools; in one region, Schmalkalden, diphtheria was rarer than in another, Malstatt-

Burbach, otherwise similar, because in the former place potatoes were bought in small quantities and immediately consumed, while in the latter place large quantities were laid in, and the people came more often in contact with spoiled potatoes.

"Now the point I wish to make about this tale, which seems so weird and ridiculous, now that we *know* what causes diphtheria, is that the statistical reasoning in the paper cited is every bit as good and as cogent as at least much of the statistical work in the field of public health in this country at this present time. We may be, and I fear too often actually are, making just as egregious spectacles of ourselves in our statistical discussions of tuberculosis, infant mortality, etc., as was the gentlemen who proved (?) that potatoes cause diphtheria. I hope that the moral of this true story is plain and will sink deep."

There is probably no advantage in presenting additional illustrations. They would only serve to strengthen the caution that one must not seek a direct, causative relationship between two sets of facts which run in parallel. There may be a connection between them, but it may be direct or very remote.

Choosing the Size of a Statistical Group.—When discussing the size of a statistical sample above it was suggested that this be taken as large as convenience permits. Although this advice has been followed in a study, it is still essential to know whether the sample was really large enough so that the statistical findings are significant. We have a mathematical rule called *Poisson's formula* (which may be found in a standard text-book on statistics) by means of which we can de-

termine whether the statistical sample was sufficiently large so that the findings are really significant or whether they are due merely to chance variations which occur when small numbers are used. Sir Arthur Newsholme has shown by Poisson's formula that if there are 7 recoveries in each 10 cases of cholera, and if this ratio of recoveries to cases is based upon only 10 cases, you may expect in the next 100,000 cases anything between 29,000 and 111,000 recoveries! In other words, a fatality deduction about cholera which is based upon a statistical sample of 10 cases is absolutely worthless. If the statistical sample upon which the deduction is based is larger, however, the accuracy of the result is proportionally greater, and you may predict with greater certainty from your deduction. This is illustrated in Table 64 from Dr. Newsholme's data.

TABLE 64

RELATION BETWEEN THE SIZE OF A STATISTICAL SAMPLE AND THE ACCURACY OF THE STATISTICAL FINDINGS

Total number of cases.	Number of recoveries.	Possible number recovering in the next 100,000 cases.
10	7	29,020 or 110,980
100	70	57,000 or 73,000
1,000	700	66,000 or 74,000
10,000	7,000	68,700 or 71,300
100,000	70,000	69,600 or 70,400
1,000,000	700,000	69,870 or 70,130

We may deduce from these figures that a statistical deduction as to fatality of a disease begins to have reasonable accuracy when it is based upon more than

1000 or 10,000 cases, but not when based upon only 10 or 100. In planning a study it is generally wise to determine first approximately how large a statistical group must be studied so that the interpretation of the results will not be vitiated by the error of chance variation in the original data.

Errors in Comparing Death-rates for Different Populations.—The errors and fallacies which come from the comparison of crude figures, crude rates, and ratios have all been commented upon in sufficient detail in preceding chapters and need not be discussed again. When we were studying the variations in mortality for white and colored persons and for different races (Chapter VII) we saw that because of the higher death-rates of the colored people, it followed that in any community in which there is an unusually large number of colored persons the crude death-rate will be unusually high. And similarly, when studying the specific death-rates from tuberculosis, we came to the same conclusion. Professor Whipple has published a very illuminating illustration of how these factors may lead to fallacious statistical results. In Table 65 (p. 232) some figures are given for the specific death-rates from tuberculosis among white and colored persons in Richmond, Virginia., and in New York City in 1910.

It is seen that for the whole populations the tuberculosis death-rate was *higher* (226) in Richmond than in New York (187). Yet the anomaly is that the death-

TABLE 65

TUBERCULOSIS IN NEW YORK AND IN RICHMOND, 1910

Class.	Population: New York.	Population: Richmond.	Deaths: New York.	Deaths: Richmond.	Death-rate per 100,000: New York.	Death-rate per 100,000: Richmond.
White.....	4,675,174	80,895	8368	131	179	162
Colored.....	91,709	46,733	513	155	560	332
Total.....	4,766,883	127,628	8881	286	187	226

rate either for whites or for negroes was *lower* in Richmond than in New York! The explanation is, of course, very simple. In New York there are so few negroes (92,000 in a population of 4,700,000) that their high death-rate does not raise the rate for the whole city very much. In Richmond there are more than half as many negroes as whites, and hence even their comparatively low negro death-rate is of sufficient importance to raise the rate for the whole population to a higher level than the corresponding rate for New York. The comparable death-rates of 226 for Richmond and 187 for New York are, of course, sound. But if one did not study them further by color subdivision one might be led to the fallacious conclusion that in apparently comparable populations tuberculosis caused greater mortality in the city of Richmond than in New York, although the real state of affairs was the reverse.

Errors in Adjusting or Standardizing Death-rates.— If we make the assumption that the specific death-rates from tuberculosis in Richmond and in New York in 1910 are really accurate, we may undertake to "stand-

ardize" or adjust the rates for the two communities to make them comparable with respect to race. This can be done in the same manner as the standardization of rates for age. (See pages 173-176.) We, therefore, undertake to determine what the death-rate from tuberculosis would have been in New York City if it had had the white-negro distribution which prevailed in Richmond, or what it would have been in Richmond if in that city the racial distribution had been that of the New York City population. Further, we may standardize the rates for the two cities against a common racial distribution. The data in Table 66 illustrate what results may be obtained, depending upon the

TABLE 66

INFLUENCE OF THE "STANDARD" UPON ADJUSTED DEATH-RATES. WHITE-NEGRO ADJUSTMENTS OF TUBERCULOSIS DEATH-RATES. NEW YORK CITY AND RICHMOND, 1910

Population basis.	Death-rate from tuberculosis per 100,000 persons: New York City.	Richmond.	Ratio: New York City—Richmond, per cent.
White persons	179	162	111
Negro persons	560	332	169
Total persons	187	226	83
White-negro ratio of New York City	187	165	113
White-negro ratio of Richmond	314	226	139
Negro 10 per cent. of total	217	179	121
Negro 30 per cent. of total	293	215	136
Negro 50 per cent. of total	369	247	149

"standard" used. We have standardized Richmond against New York as a standard; New York against Richmond as a standard; and the two against hypothetical standards which included, respectively, 10 per

cent., 30 per cent., and 50 per cent. negroes in the population. The ratio of the New York rates to the Richmond rates are given in the last column.

Thus we observe what markedly different "adjusted" death-rates one can obtain by appropriate (or inappropriate) choice of a "standard." When the death-rates of the two communities are based upon the same race distribution, the New York City rate is, of course, always higher than the Richmond rate. The *extent* to which it is higher depends upon the standard used. In the examples chosen the ratio of the New York City to the Richmond rates ranged from 111 to 149 per cent., depending upon the proportion of negro persons in the standard population. The caution with which a "standard" million must be chosen has been mentioned once before (see page 176). Carelessness in this regard has played no small rôle in confusing the issues involved in such highly controversial problems as the trend of the cancer death-rate where "standardized" rates are used with utter abandon.

The Importance of Understanding the Statistical Data.—One other source of statistical error and of fallacious interpretation need be discussed, namely, that which is concerned with lack of familiarity with the data which is being studied. It is one which is of particular importance now because the tables are being turned in the realms of vital statistics, and instead of incompetent mathematicians working with data which

they understand, the tendency is becoming for competent mathematicians to study vital statistics whose accurate collection and interpretation (unless they first undertake careful study of them) lie outside the field of their mathematical competence.

It is essential that anyone working with data of the United States Census shall know how the census was taken. When studying age distributions, for example, it is important to know that the ages of persons canvassed are obtained not from their birth certificates, but from personal statement. Obviously there will be frequent inaccurate statements out of ignorance on the part of many persons of their exact age or because of desire for purposive concealment. It is a matter of common knowledge that the ages of children under five years are notably inaccurate, that a very large percentage of old persons overstate their ages, and that at all ages there is an undue grouping of persons at the five-and ten-year marks. A person working with such census data, whether with respect to age, nationality, occupation, etc., must understand how they were obtained and must appreciate these sources of error. Otherwise he will very often be led astray. In the text of previous chapters we have already discussed more fully errors in the interpretation of birth and mortality statistics, particularly with respect to comparative birth and specific mortality rates and with respect to the trend of mortality from specific causes of death.

In interpreting some statistics of a typhoid fever epidemic a few years ago one of the leading statisticians of Great Britain was led into a fallacy which is very illuminating. It illustrates what may come of working with statistics whose collection and *statistical* accuracy one may understand, but of whose meaning one may be in profound ignorance. In the report to which I refer the statistician reported that the curve of the seasonal distribution of enteric (typhoid) fever was similar to that of the temperature of the water-supply. Inasmuch as the epidemic was considered water-borne, the explanation of the sequence of the epidemic—it was said—was that the warmer the drinking-water, the more rapidly the bacteria multiplied in number, and hence the larger the number of typhoid cases. It is a fact that the higher the temperature, up to a certain point, the more rapidly bacteria grow. It is also a fact, however, that in drinking-water bacteria do not grow; they only die for lack of food materials, and they die faster the warmer the water! In other words, the warmer the water, the smaller—not the larger—should have been the number of typhoid cases; and conversely, the colder the water, the larger the number of cases. The suggested explanation of the epidemic probably has no shred of accuracy in it. The true explanation of the epidemic curve is probably in the scope of biologic factors beyond the understanding of the mathematician. The lesson to be drawn from this example is clear.

The Usefulness of Vital Statistics.—"Statistics," as the vernacular has it, are in poor repute. You can prove anything with them, it is said. Perhaps you can, to the gullible, but you can't—sometimes with statistics or without—to the skeptical one. When statistics are quoted, a reader is entitled to a description of where they come from, who collected them, and what has been done to them. Happily the field of *Vital* Statistics is in better repute than certain others. It is probably due to the fact that, on the whole, they have been handled with greater care by persons who have understood them better and who have attempted to utilize them more scrupulously. Their usefulness is very great; their fields of application multitude; and their value is proportional to the care and accuracy with which they are collected, manipulated, and interpreted.

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The following selected list of references is presented as an aid to the teacher, the student, or the general reader who, dissatisfied with the cursory treatment given to so many subjects in the text, may wish to delve more deeply into the literature of Vital Statistics. The titles which are presented here may be regarded as the results of an aëroplane flight over the extensive literature which is available to the statistician. Only publications in the English language and such as are of general or particular importance or which contain valuable bibliographies to specific topics have been included. When selecting the titles an effort was made to lay particular stress upon such books and papers as are available in community or university libraries or are readily obtainable from the publishers.

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